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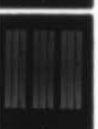
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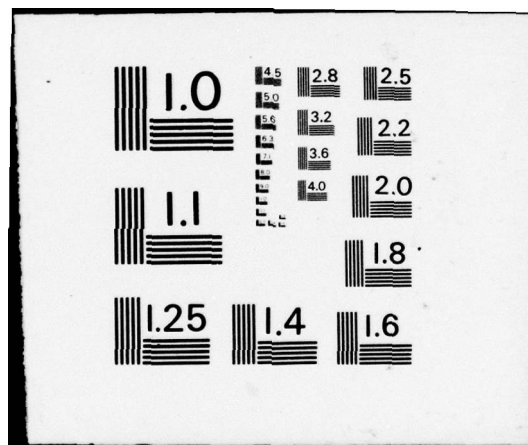
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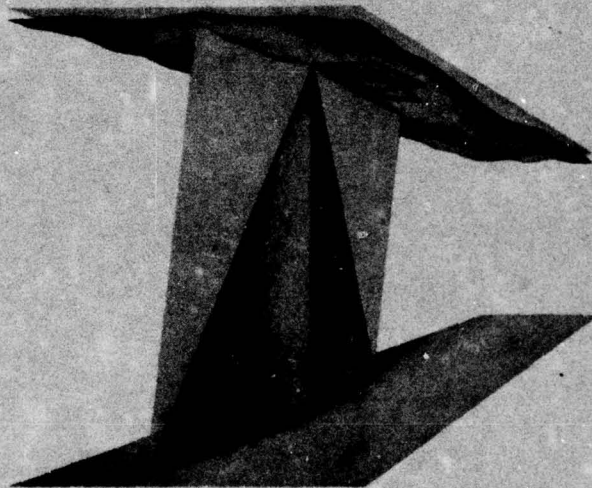


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SIMPLIFIED VLF/LF MODE CONVERSION PROGRAM WITH ALLOWANCE FOR ELEVATED, ARBITRARILY ORIENTED ELECTRIC DIPOLE ANTENNAS

Interim Report No. 771

R. A. Pappert and L. R. Shockey



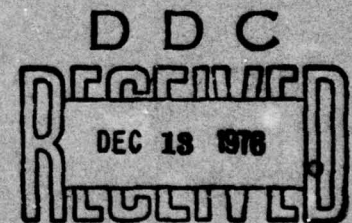
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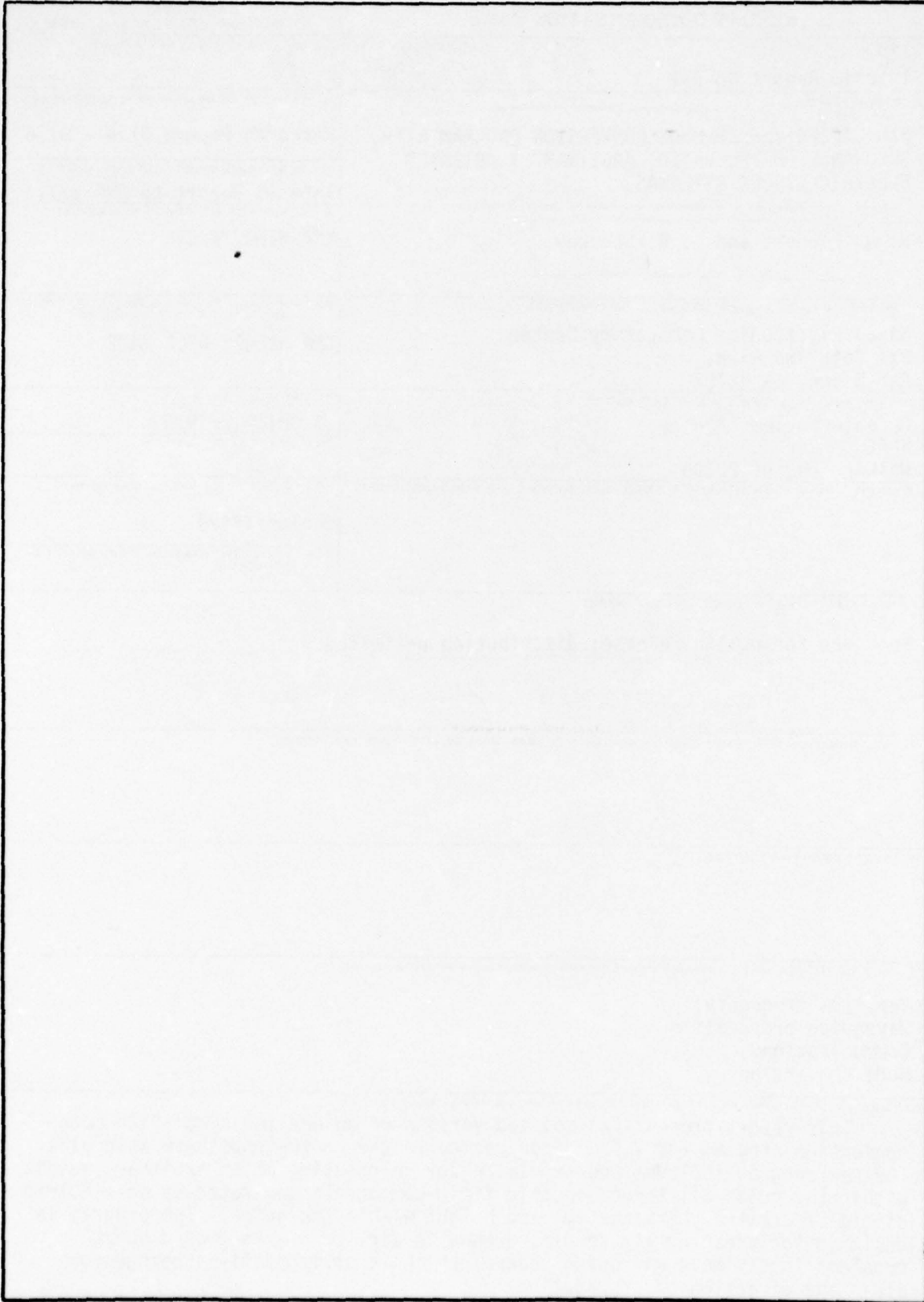
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ELECTRIC DIPOLE ANTENNAS

By
R. A. Pappert
and
L. R. Shockey

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ABSTRACT

This report presents an updated version of an earlier simplified mode conversion program for VLF/LF propagation in the earth-ionosphere waveguide. The new program includes the provision for calculating at an arbitrary height within the guide all three electric field components generated by an electric dipole of arbitrary orientation and height within the guide. The program is designed for treating air to air, ground to air or air to ground VLF/LF problems involving a waveguide channel which is horizontally inhomogeneous along the direction of propagation.



I. Introduction

This report is a continuation of a series (references 1, 2 and 3) which describes computer programs developed for calculating VLF/LF field strengths in the earth-ionosphere waveguide when allowance must be made for horizontal inhomogeneity in the direction of propagation. Thus these programs are particularly relevant to the problem of propagating across the terminator as well as to the problem of propagating in an artificially disturbed environment. As in the previous works, the present program is based upon a slab model, assumes waveguide invariance in the direction normal to the great circle path between transmitter and receiver and neglects reflections resulting from inhomogeneity along the direction of propagation. The field calculations, principally through waveguide modal constant inputs, do allow for vertical inhomogeneity as well as anisotropy of the ionosphere. In the previous works, field strength calculations or mode sums are generated for the vertical electric field, E_z , at the ground produced by a ground based vertical dipole. The present program differs from that of reference 3 only to the extent that the present program can be used to calculate all electric field components E_z , E_x and E_y for any receiver height within the guide (x - z is the plane of propagation). Furthermore, the field strength calculations can be made for electric dipole exciters of arbitrary orientation located at any height within the guide. Thus air to air, ground to air or air to ground VLF/LF propagation problems involving a horizontally inhomogeneous waveguide channel may be treated using the present program.

In addition to familiarity with the simplified mode conversion model concepts documented in references 2 and 3, familiarity is assumed with reference 4 which describes a Fortran IV program for obtaining mode constants as well as excitation factors for electric dipoles of arbitrary orientation located at

any height within the earth ionosphere waveguide. Crucial inputs from the latter program are the ground eigenangles, four independent quantities from which a tensor array of nine excitation factors relating to end-on, broadside or vertical dipole excitation of E_z , E_x and E_y may be determined, and a polarization factor which introduces the proper amount of TE wave into the modal height gains. These quantities for each mode and slab serve as input for the present program.

Principal outputs of the present program are mode conversion coefficients (in a generalized sense) and mode sum plots as a function of distance from the transmitter for the three electric field components for four orientations of the electric dipole exciter. The transmitter and receiver must be within the earth curvature dominated portion of the guide but otherwise their altitude is arbitrary. Since the mode conversion coefficients are independent of the location of the horizontal inhomogeneity relative to the transmitter, provision is made for moving the inhomogeneity in increments and plotting mode sums for the incremented distances (this option is useful only if the ground conductivity and geomagnetic orientation may be regarded as constant over the path).

In section II the mode conversion model is reviewed and relevant formulas summarized. A description of the program is given in section III and results presented in section IV. The appendix contains a program listing.

II. Summary of Equations

Inputs to the present program for each slab and mode are the ground eigenangles, the T_j 's defined below and the polarization ratio f also defined below. The T_j 's are readily obtainable from the waveguide program documented in reference 4 as are the eigenangles and polarization ratio. These quantities are

$$T_1 = \frac{S^{1/2} (1 + {}_{11}\bar{R}_{11})^2 (1 - {}_{\perp}R_{\perp} {}_{\perp}\bar{R}_{\perp})}{F'(\theta_n) {}_{11}\bar{R}_{11} D_{11}} \quad (1)$$

$$T_2 = \frac{S^{1/2} (1 + {}_{\perp}\bar{R}_{\perp})^2 (1 - {}_{11}R_{11} {}_{11}\bar{R}_{11})}{F'(\theta_n) {}_{\perp}\bar{R}_{\perp} D_{22}} \quad (2)$$

$$T_3 = \frac{S^{1/2} (1 + {}_{11}\bar{R}_{11}) (1 + {}_{\perp}\bar{R}_{\perp}) {}_{11}R_{11}}{F'(\theta_n) D_{12}} \quad (3)$$

$$T_4 = \frac{{}_{\perp}R_{11}}{{}_{11}R_{\perp}} \quad (4)$$

$$f = \frac{e_y}{h_y} = \frac{(1 + {}_{\perp}\bar{R}_{\perp}) (1 - {}_{11}R_{11} {}_{11}\bar{R}_{11})}{(1 + {}_{11}\bar{R}_{11}) {}_{\perp}R_{11} {}_{\perp}\bar{R}_{\perp}} = \frac{(1 + {}_{\perp}\bar{R}_{\perp}) {}_{11}R_{\perp} {}_{11}\bar{R}_{11}}{(1 + {}_{11}\bar{R}_{11}) (1 - {}_{\perp}R_{\perp} {}_{\perp}\bar{R}_{\perp})} \quad (5)$$

S is the sine of the eigenangle and $F'(\theta_n)$ the derivative of the mode equation evaluated at the eigenangle, θ_n . The R and \bar{R} 's represent, respectively, elements of the reflection matrix looking into the ionosphere and towards the ground from ground level. Consistent with the usual notation, the first subscript refers to the polarization of the incident wave and the second subscript refers to the polarization of the reflected wave. Equation (5) gives

the ratio of e_y to h_y at the ground. The function f is also called $F\phi R$ in this program. The D_{ij} 's are functions defined below which are negated in the present program by defining

$$\tau_1 = D_{11}T_1, \quad \tau_2 = D_{22}T_2, \quad \tau_3 = D_{12}T_3 \quad (6)$$

In terms of the preceding quantities the excitation tensor elements are

$$\lambda = ((\lambda_{ij})) = \begin{array}{c} \text{FIELD COMPONENT} \rightarrow \\ \begin{pmatrix} E_z & E_x & E_y \\ \tau_1 S^2 & \tau_1 S & -\tau_3 S/f \\ -\tau_1 S & -\tau_1 & \tau_3/f \\ -\tau_3 T_4 S/f & -\tau_3 T_4/f & \tau_2/f^2 \end{pmatrix} \end{array} \begin{array}{c} \text{EXCITER} \\ \downarrow \\ \text{VERTICAL} \\ \text{END-ON} \\ \text{BROADSIDE} \end{array} \quad (7)$$

The columns relate to excitation of the electric field components E_z , E_x and E_y and the rows apply to excitation by a vertical dipole, a horizontal dipole end-on and a horizontal dipole broadside. Recall the geometry of the situation is such that z is taken positive into the ionosphere, that positive x is the direction of propagation and that y is normal to the plane of propagation.

The excitation factors must be supplemented with definitions of the height gains. These along with the definitions of the D_{ij} 's are

$$f_1(z) = \exp(z/a) (F_1 h_1(q) + F_2 h_2(q)) / (F_1 h_1(q_0) + F_2 h_2(q_0)) \quad (8)$$

$$f_2(z) = \frac{1}{ik} \frac{df_1}{dz} \quad (9)$$

$$f_3(z) = (F_3 h_1(q) + F_4 h_2(q)) f / (F_3 h_1(q_0) + F_4 h_2(q_0)) \quad (10)$$

$$D_{11} = (F_1 h_1(q_0) + F_2 h_2(q_0))^2 \quad (11)$$

$$D_{12} = (F_1 h_1(q_0) + F_2 h_2(q_0)) (F_3 h_1(q_0) + F_4 h_2(q_0)) \quad (12)$$

$$D_{22} = (F_3 h_1(q_0) + F_4 h_2(q_0))^2 \quad (13)$$

$$F_1 = -H_2(q_0) + i \frac{n_0^2}{N_g^2} \left(\frac{\partial k}{\partial z} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_2(q_0) \quad (14)$$

$$F_2 = H_1(q_0) - i \frac{n_0^2}{N_g^2} \left(\frac{\partial k}{\partial z} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_1(q_0) \quad (15)$$

$$F_3 = -h_2'(q_0) + i \left(\frac{\partial k}{\partial z} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_2(q_0) \quad (16)$$

$$F_4 = h_1'(q_0) - i \left(\frac{\partial k}{\partial z} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_1(q_0) \quad (17)$$

$$q = \left(\frac{\partial k}{\partial z} \right)^{2/3} (C^2 + 2z/a) \quad (18)$$

$$H_j(q) = h_j'(q) + \frac{1}{2} \left(\frac{\partial k}{\partial z} \right)^{2/3} h_j(q) \quad ; \quad j = 1, 2 \quad (19)$$

$$n^2 = 1 + 2z/a \quad (20)$$

$$N_g^2 = \epsilon/\epsilon_0 - i\sigma/\omega\epsilon_0 \quad (21)$$

C = cosine of the ground eigenangle

k = the free space wavenumber

ϵ/ϵ_0 = dielectric constant of the ground

σ = the ground conductivity
 ω = the circular radio frequency
 a = the earth's radius

The functions h_1 and h_2 are modified Hankel functions of order $1/3$ (which are linearly related to Airy functions) as defined by the Computation Laboratory at Cambridge, Massachusetts (reference 5) and the primes on these quantities denote derivatives with respect to the argument. Equation (20) is the modified refractive index which is chosen to be unity at the ground. The subscript, o , which appears on n^2 in equations (14) and 15) signifies that Eq (20) is to be evaluated for $z = 0$. Similarly the subscript o which appears on q in Eq (8) and Eqs. (10) through (17) signify that Eq. (18) is to be evaluated for $z = 0$. It should be pointed out that f_1 (apart from a sine of the eigenangle) is the height gain for the vertical electric field E_z , f_2 the height gain for the horizontal electric field component E_x , and f_3 for the electric field component E_y which is normal to the plane of propagation. Unlike the eigenangles, the T_j 's and the polarization ratio, the height gains are generated in the present program.

The final quantities required for the mode sum evaluations are the generalized mode conversion coefficients A_{jk}^p which are also calculated in the present program. Details of their calculation are described in references 2 and 3 and we will remark here only that the quantities relate to the amplitude of the j^{th} mode in slab p generated by virtue of a unit amplitude wave incident in the transmitter region (slab NTR in the present program - see Fig. 1).

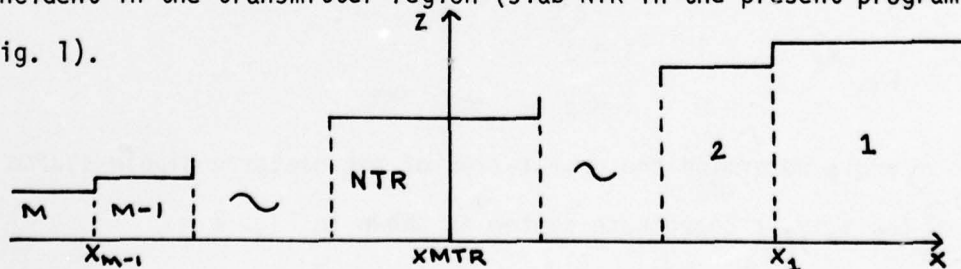


Fig. 1 MODE CONVERSION MODEL

In terms of the excitation factors, height gains and generalized mode conversion coefficients the electric field components E_ℓ^p in the p^{th} slab may be written as follows

$$E_\ell^{\text{NTR}} = \frac{Q}{[\sin(x/2)]^{1/2}} \sum_k \left(\lambda_{1\ell k}^{\text{NTR}} f_{1k}^{\text{NTR}}(z_T) \cos\gamma + \lambda_{2\ell k}^{\text{NTR}} f_{2k}^{\text{NTR}}(z_T) \sin\gamma \cos\phi \right. \\ \left. + \lambda_{3\ell k}^{\text{NTR}} f_{3k}^{\text{NTR}}(z_T) \sin\gamma \sin\phi \right) f_{\ell k}^{\text{NTR}}(z_R) e^{-ik(s_k^{\text{NTR}} - 1)x} \quad (22)$$

$$E_\ell^p = \frac{Q}{[\sin(x/2)]^{1/2}} \sum_j \sum_k \left(\lambda_{1\ell k}^{\text{NTR}} f_{1k}^{\text{NTR}}(z_T) \cos\gamma + \lambda_{2\ell k}^{\text{NTR}} f_{2k}^{\text{NTR}}(z_T) \sin\gamma \cos\phi \right. \\ \left. + \lambda_{3\ell k}^{\text{NTR}} f_{3k}^{\text{NTR}}(z_T) \sin\gamma \sin\phi \right) (\delta_{1\ell} + (1 - \delta_{1\ell}) s_k^{\text{NTR}} / s_j^p) f_{\ell j}^p(z_R) A_{jk}^p \\ \times e^{-ik(s_k^{\text{NTR}} x_{\text{NTR}-1} + s_j^p(x - x_p) - x)} \quad ; \quad p \neq \text{NTR} \quad (23)$$

The receiver altitude is z_R and the transmitter altitude z_T . The final subscript on the λ 's and f 's denotes mode indices whereas the index ℓ takes on the values 1, 2 and 3. Consistent with the previous definition $\ell = 1 \rightarrow E_z$, $\ell = 2 \rightarrow E_x$ and $\ell = 3 \rightarrow E_y$. The constant Q is

$$Q = 0.03248k/\sqrt{F}$$

with the free space wavenumber, k , in inverse km and F the frequency in kHz.

The symbol δ_{ij} represents the Kronecker delta. That is

$$\delta_{ij} = \begin{matrix} 1 & i = j \\ 0 & i \neq j \end{matrix}$$

The angles γ and ϕ determine the orientation of the electric dipole source relative to the x, y, z coordinate system as shown in Fig. 2

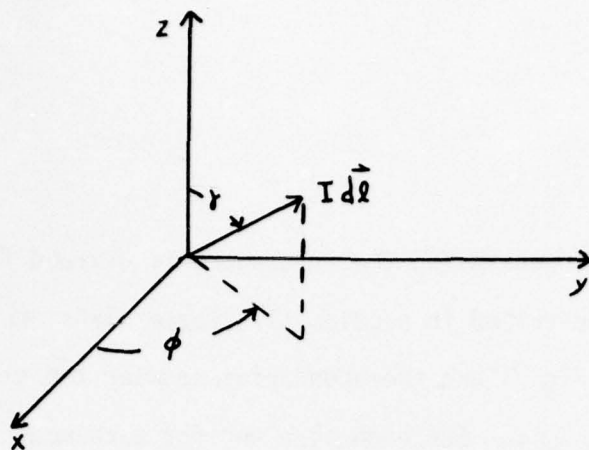


Fig. 2. Dipole Orientation

Two distinct options are available with the present program. One is for field calculations (amplitude and phase) as a function of range for a fixed location of the horizontal inhomogeneity. The second allows for field calculations at two distinct receiving points along the same great circle path as a function of position of the horizontal inhomogeneity (this option is useful only if the ground conductivity and the geomagnetic parameters are invariant over the path). Amplitude is expressed in dB above a microvolt per meter for a one kilowatt radiator and phase in degrees relative to free space. Both of these quantities are printed outputs of the program. Amplitude plots may also be requested.

III. Description of Program

A. General Comments

To handle horizontal inhomogeneities, the ionosphere is divided into a series of vertical slabs, as described in section II. These slabs are labeled 1, 2, . . . , M as shown in Fig. 1 and the boundaries between the slabs have coordinates X_1, X_2, \dots, X_{M-1} . For each slab and for each mode the ground eigenangle, the T_j 's defined by Eqs. (1) through (4) and the function f (called $F\theta FR$) defined by Eq. (5) must be provided.

B. Description of Input

All input to the mode conversion program is given in a data deck on the standard input unit. A listing of sample input, showing the data deck setup is given on pages 17 through 19.

There are two parts to the input. The first part is read in by means of a Fortran IV NAMELIST input format. The first card of each set of input must contain a blank in column 1 and &DATUM in columns 2- 7. This is followed by at least one blank and then data items separated by commas. The data items have the following forms: (all cards must have a blank in column 1)

variable name = constant,

or

array name = set of constants, (all separated by commas), where successive occurrences of the same constant can be represented by $k \star$ constant; for example, in the sample input, $\text{sigma} = 9 \star 4.64$ means that the conductivity for all nine slabs is 4.64 mhos/m.

The following variables and arrays may be specified in the NAMELIST input:

FREQ - frequency in kHz.

SIGMA - ground conductivity in mhos per metre. Note that a ground

conductivity for each slab is required and that SIGMA is dimensioned for 25.

EPSLØN - permittivity of ground in Farads per metre. Note that a ground permittivity for each slab is required and that EPSLØN is dimensioned for 25.

RHØMAX - maximum horizontal distance in km at which field strengths are desired.

RHØMIN - minimum horizontal distance in km at which field strengths are desired.

DEL RHØ - horizontal increment in km for which successive field strengths are computed.

IDPLØT - literal constant up to 40 characters which is printed on plots produced. For example, in the NAMELIST input data, place the card IDPLØT = 'FIELD STRENGTH PLØT'. If IDPLØT is set to zero or if IDPLØT is omitted from input no plots are produced.

NRSLAB - Number of slabs in the model.

NRMØDE - Number of modes to be handled in the program.

NTMAX - Number of times the transmitter - terminator separation is incremented.

DELTA X - Distance in km by which transmitter - terminator separation is incremented.

XVAL - Horizontal position in km of boundaries between adjacent slabs. Note that XVAL can be negative and that it is dimensioned for 25.

IFIRST - Is set to 1 in the first set of NAMELIST input. If more than one set of input is used set IFIRST = 0 in the second set.

LAST - Is set to 1 in the last set of NAMELIST input. If the user has requested plots this causes the end of file to be written on the plot tape.

IPLTØP - Plotting option flag. If IPLTØP = 1 two plots (field amplitude in dB above a $\mu\text{V/m}$ for 1 kw radiated power versus transmitter - terminator

distance for two receiver positions) are produced for each set of input. If $IPLTOP = 2$, NTMAX plots (field amplitude in dB above a $\mu v/m$ for 1 kw versus distance from transmitter) are produced for each set of input.

XMIN - minimum value of X on plot.

XINC - increment of X scale in km/inch.

YMIN - minimum value of y on plot.

YINC - increment of y scale in dB/inch.

SIZEX - size of X axis in inches.

SIZEY - size of y axis in inches.

GAMMA - dipole orientation angle relative to z axis (see Fig. 2). Note that GAMMA is dimensioned for 4.

PHI - dipole orientation angle relative to X axis (see Fig. 2). Note that PHI is dimensioned for 4.

NRP - number of GAMMA-PHI pairs up to 4.

ZT - transmitter altitude in km.

ZR - receiver altitude in km.

INTFLG - Printing option flag. INTFLG must be set to 1 if printout of height gain integrals is required. See reference 2 for an output of height gain.

IPRNTA - Printing option flag. IPRNTA must be set for 1 if printout of generalized mode conversion coefficients is required.

The end of the NAMELIST input is signaled by &END.

The second part of the input follows the NAMELIST input. Three cards per mode are required. The first contains the eigenangle at the ground and T_1 and T_2 (see Eqs. 1 and 2). The second contains the eigenangles at the ground (duplicate input) and T_3 and T_4 (see Eqs. 3 and 4). The third card contains f (see Eq. 5) and $TOPHT$. The latter in this program is a real variable and

represents the height above ground in km above which height gains are discarded. TØPHT is dimensioned for 25. There must be 3*NRMØDE cards for each slab. The 3*NRMØDE cards for slab 2 follow those for slab one and so on up to slab number NRSLAB. Although ordering of modes is not critical, we have followed the practice of ordering them according to their real parts. (The mode with the largest real part is called mode 1).

C. Description of Output

The sample output shown on pages 20 through 42 begins with an abbreviated listing of the NAMELIST input variables. This is followed by a printout of THETA, T_j 's and FØFR for all slabs and modes. THETA is the eigenangle at the ground, the T_j 's are the complex quantities given by Eqs. (1) through (4) and FØFR is the complex quantity f defined by Eq. (5).

The principal output of the mode conversion program begins on page 21 where the total mode conversion coefficients defined by Eq. (24) of reference 2 are printed for each slab (we remark that they are mode conversion coefficients in the generalized sense that the modes are not an orthogonal set). The tabulation represents the conversion from k to j and appears as printout because IPRNTA was set to 1 in the input. On the other hand height gain integrals have been suppressed in the output because INTFLG was not set equal to 1 in the input. Since IPLTØP was set equal to 2 the sample output shows mode sums for the three electric field components E_z , E_x and E_y as a function of transmitter-receiver distance ranging from RHØMIN to RHØMAX at DELRHØ intervals. The mode sums are listed in dB/ μ V/m for a one kilowatt radiator and the phases in degrees relative to free space. Because NRP = 4 in the input, there are four GAMMA-PHI pairs (i.e. four antenna orientations) for which the mode sums are computed. Shown on pages 45, 46 and 47 in section IV are reductions of the plots generated by the mode conversion program for this case along with

WKB results. The mode conversion results and WKB results are shown together for program check purposes as discussed in section IV.

D. Program Layout

This subsection describes the basic features of the mode conversion program listed in the appendix.

Reading and printing of input quantities occurs in MAIN as does calculation of constant factors. These quantities are assigned to common areas MCINPT or MCSTOR. MAIN calls HTINTL and HTGAIN for each slab MM.

SUBROUTINE HTINTL (CAPI, NØRM, IFLG, M, INTFLG)

HTINTL calculates the height integrals defined by Eq. (4) in reference 3. NØRM is an array of 25 by 5 by 5 which contains all combinations of modal integrals for the slab M. Also CAPI is an array of 25 by 5 by 5 which contains all combinations of modal height gain integrals for the slab M and the previous slab M+1. IFLG is a control flag set to zero in MAIN if the slab M equals NRSLAB. It is set to 1 if M is not equal to NRSLAB. INTFLG is a printing option flag. It must be set to 1 if printout of NØRM and CAPI is desired. NØRM and CAPI are assigned to the common area CAP in MAIN where they are called TNØRM and CAPI. HTINTL calls MDHNKL

SUBROUTINE MDHNKL (Z, H1, H2, H1PRME, H2PRME)

MDHNKL calculates for argument Z two independent solutions (H1 and H2) and their derivatives (H1PRME and H2PRME) of Stokes' equation by methods described in reference 5. MAIN next calls HTGAIN.

SUBROUTINE HTGAIN (Z)

Z is dimensioned for 2. Z(1) is set equal to the transmitter height ZT and Z(2) is set equal to the receiver height. The height gain functions f_1 , f_2 and f_3 defined by Eqs. (8), (9) and (10) respectively are computed for the

transmitter and receiver heights. These are made available to MCFLD and MCFLD2 through COMMON/HTGN/.

MAIN next calls MCSTEP for slabs equal to NTR (transmitter slab), NTR-1, . . . , 1 with allowance for changes in NTR consistent with the input data.

SUBROUTINE MCSTEP (M)

MCSTEP calls for CLINEQ and provides as its output the mode conversion coefficients for the slabs NTR, NTR-1, . . . , 1 for all values of NTR consistent with the input data. The mode conversion coefficients defined by Eq. (24) of reference 2 are printed out under the "A = TOTAL CONVERSION COEFFICIENTS" label.

SUBROUTINE CLINEQ (A, B, X, N, NDIM, IFLAG, ERR)

CLINEQ computes the solution of simultaneous linear equations with complex coefficients. That is it solves the matrix equation

$$A * X = B$$

for the vector X of length N, given the matrix A of size N by N and the vector B of length N by Crout's L-U decomposition (reference 6). The A is destroyed by CLINEQ, NDIM is an integer variable which must be greater than or equal to N. IFLAG is an integer variable normally set to zero. Setting IFLAG = 1 bypasses the L-U decomposition of A when solutions are required for different B's. ERR is a real variable computed by CLINEQ which indicates the relative errors in the computed solution vector X.

SUBROUTINE MCFLD

MCFLD called from MAIN if IPLTOP = 1 computes the field components E_z^M defined by Eqs. (22) and (23) for transmitter height ZT and receiver height ZR for as many as four (GAMMA, PHI) pairs. GAMMA and PHI describe the orientation of the electric dipole source. Calculations are made for ranges RHOMIN and RHOMAX for distances between the transmitter and the start of the horizontal

inhomogeneity ranging between XVAL (NRSLAB-1) and NTMAX*DELTAX +XVAL(NRSLAB-1) at intervals of DELTAX using Eqs. (22) and (23). Field amplitude outputs are in dB above a μv per metre for 1 kw radiated power and phase angles are in degrees relative to free space phase.

SUBROUTINE MCFLD2

MCFLD2 called from MAIN if IPLTOP = 2 computes the field components E_{ℓ}^M defined by Eqs. (22) and (23) for transmitter height ZT and receiver height ZR for as many as four (GAMMA, PHI) pairs. Calculations are made for transmitter-receiver distances ranging from RHOMIN to RHOMAX at DELRH0 intervals using Eqs. (22) and (23) for a fixed horizontal inhomogeneity. Field amplitude outputs are dB above a μv per metre for 1 kw radiated power and phase angles are in degrees relative to free space phase.

SUBROUTINE MCPLTS

MCPLTS generates six plots (three field component amplitudes in dB above a μv per metre for 1 kw radiated power versus distance between transmitter and start of the horizontal inhomogeneity for two receiver ranges). As many as four (GAMMA, PHI) pairs are possible so that each plot can contain as many as four curves.

SUBROUTINE MCPLT2

MCPLT2 generates three plots (three field component amplitudes in dB above a μv per metre for 1 kw radiated power versus transmitter receiver distance for a single location of the horizontal inhomogeneity). As many as four (GAMMA, PHI) pairs are possible so that each plot can contain as many as four curves.

SUBROUTINE MAGANG (ARG, MAG, ANGLE)

MAGANG converts complex number ARG to polar form with ANGLE in degrees.

SAMPLE INPUT

```

&DATUM
IDPLOT=*HPRIME = 70 TO HPRIME = 71
FREQ=21.794,
RHOMIN=25.,RHOMAX=5000.,DELRHO=25.,DELTAX=0.,NTMAX=1,
NRSLAB=9,NRMODE=5,
SIGMA = 9*4.64, EPSLON = 9*.7172014E-09,
XVAL=1025.,837.5,712.5,587.5,462.5,337.5,212.5,25.,0.,
GAMMA=0.,90.,90.,45.,PHI=0.,0.,90.,45.,NRP=4,
ZT=5.,ZR=10.,
XMIN=0.,XINC=500.,YMIN=-80.,YINC=20.,SIZEX=10.,SIZEY=8.,
IPRNTA=1,IPLTOP=2,IFIRST=1,
LAST=1,
&END

```

```

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2 89.43090 -3.45987 2.175780870-08 1.890151640-08 1.310387010-01 7.290033340-01
89.43090 -3.45987 4.612300-02 1.77108 -0.547118400-07 1.160153190-06 71.00
1 87.19352 -1.77741 4.825157780-05-1.842023180-05-6.046535120-11-2.407738400-11
2 87.19352 -1.77741 -4.263745280-08-5.212645140-08 1.365817340-01 7.285013610-01
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1 82.32644 -1.03410 1.511146650-03-3.752447000-02 2.822266770-14-3.372784000-13
2 82.32644 -1.03410 7.596839750-08 1.068389410-07 1.547947470-01 7.232262650-01
82.32644 -1.03410 7.838110-02 1.60618 -2.761173930-06 2.135698020-06 71.00
1 79.02547 -1.34370 1.178668510-04-1.053815670-05-3.266061990-10-9.727339090-11
2 79.02547 -1.34370 -1.251140150-07-1.967257580-07 1.746201820-01 7.210867230-01
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1 75.47092 -1.35774 1.582716240-03-3.386069990-02 2.468936600-13-3.541508280-12
2 75.47092 -1.35774 2.225136400-07 3.340343850-07 2.058807710-01 7.180996150-01
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1 89.42754 -3.44563 4.342383310-03-2.131711800-02-1.332274610-14-2.403851250-14
2 89.42754 -3.44563 2.119046920-08 1.866059470-08 1.330342780-01 7.380571940-01
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1 78.99378 -1.34503 1.149190350-04-9.220245020-06-3.288871380-10-9.769304600-11
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2 89.42067 -3.41703 2.010105360-08 1.818570540-08 1.374169710-01 7.558491620-01

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1 86.96840 -1.67302 3.96667679D-05-1.18420638D-05-6.45570478D-11-2.53902258D-11
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1 86.93613 -1.65973 3.85313176D-05-1.10906033D-05-6.51499112D-11-2.55845214D-11
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2 75.17244 -1.40645 1.81380698D-07 3.02886026D-07 2.24327458D-01 7.97410365D-01
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SAMPLE OUTPUT

EDATUM
 LOPL0T=HPRIME = 70 TC HPRIME = 171
 FREQ=21.794,
 RHOMIN=25.,RHOMAX=5000.,DELRHO=25.,DELTA=0.,NTMAX=1,
 NRSLAB=9,NRMODE=5,
 SIGMA = 9*4.64, EPSLON = 9*7172014E-09,
 XVAL=1025.,837.5,712.5,587.5,462.5,337.5,212.5,25.,0.,
 GAMMA=0.93,0.5,0.45,0.3,0.2,0.1,0.05,0.02,0.01,0.005,
 ZT=5.,ZR=10.,
 AMIN=0.,XINC=500.,YMIN=-80.,YINC=20.,SLCEX=L0.,SIZEY=8.,
 IPRINT=1,IPLTOP=2,IFIRST=1,
 LAST=1,
 \$END

THETA	T1	T2	T3	T4	FUFR	TUPTHT
89.431 -3.460	0.4330-02-0.2120-21	-0.11410-13-0.2470-13	0.2480-07 0.1890-07	0.1310 00 0.7290 00	-0.6530-06 0.1160-05	71.0
87.194 -1.777	0.4830-04-0.1840-24	-0.0050-10-0.2310-10	-0.4260-07-0.5210-07	0.1370 00 0.7290 00	-0.4110-03-0.1240-02	71.0
82.326 -1.034	0.1510-02-0.5750-01	0.2820-13-0.3370-12	0.7300-07 0.1070-06	0.1550 00 0.7230 00	-0.2760-05 0.2140-05	71.0
79.325 -1.344	0.1180-03-0.1350-24	-0.3270-09-0.9730-13	-0.1250-06-0.1970-06	0.1750 00 0.7210 00	-0.3050-03-0.1750-02	71.0
75.471 -1.354	0.1580-02-0.3390-21	0.2470-12-0.3540-11	0.1250-06 0.1340-06	0.2060 00 0.7160 00	-0.0950-05 0.7020-05	71.0
89.428 -3.446	0.4340-02-0.2130-21	-0.1130-10-0.2400-13	0.2410-07 0.1870-07	0.1330 00 0.7380 00	-0.3640-06 0.1150-05	73.9
87.161 -1.761	0.4700-04-0.1130-24	-0.0130-10-0.2430-13	-0.4160-07-0.5150-07	0.1390 00 0.7360 00	-0.4240-03-0.1250-02	73.9
82.234 -1.336	0.1500-02-0.5760-01	0.3120-13-0.3300-12	0.7430-07 0.1050-06	0.1550 00 0.7330 00	-0.2720-05 0.2390-05	73.9
78.994 -1.345	0.1150-03-0.2420-25	-0.3290-09-0.9770-13	-0.1220-06-0.1940-06	0.1770 00 0.7310 00	-0.3920-03-0.1760-02	73.9
75.434 -1.364	0.1600-02-0.3390-21	0.2470-12-0.3540-11	0.1250-06 0.1340-06	0.2080 00 0.7280 00	-0.0940-05 0.6840-05	73.9
89.424 -3.421	0.4360-02-0.2140-21	-0.1160-10-0.2410-13	0.2400-07 0.1840-07	0.1350 00 0.7470 00	-0.3630-06 0.1190-05	73.8
87.129 -1.765	0.4570-04-0.1630-24	-0.0160-10-0.2440-13	-0.4130-07-0.5280-07	0.1410 00 0.7470 00	-0.4310-03-0.1210-02	73.8
82.272 -1.339	0.1510-02-0.5760-01	0.3330-13-0.3230-12	0.7460-07 0.1040-06	0.1570 00 0.7430 00	-0.2680-05 0.2040-05	73.8
78.961 -1.345	0.1120-03-0.2420-25	-0.3310-09-0.9850-13	-0.1190-06-0.1920-06	0.1790 00 0.7400 00	-0.3940-03-0.1780-02	73.8
75.396 -1.373	0.1620-02-0.3400-21	0.2470-12-0.3530-11	0.1240-06 0.1320-06	0.2100 00 0.7300 00	-0.0920-05 0.6870-05	73.8
89.421 -3.417	0.4370-02-0.2160-21	-0.1160-10-0.2420-13	0.2410-07 0.1840-07	0.1370 00 0.7560 00	-0.3620-06 0.1060-05	73.6
87.037 -1.733	0.4440-04-0.1530-24	-0.0220-10-0.2480-13	-0.4170-07-0.5320-07	0.1430 00 0.7550 00	-0.4310-03-0.1280-02	73.6
82.245 -1.042	0.1530-02-0.5770-01	0.3650-13-0.3160-12	0.7490-07 0.1030-06	0.1600 00 0.7510 00	-0.2650-05 0.1940-05	73.6
78.929 -1.347	0.1090-03-0.6340-25	-0.3340-09-0.9890-13	-0.1170-06-0.1890-06	0.1820 00 0.7500 00	-0.3960-03-0.1790-02	73.6
75.359 -1.376	0.1640-02-0.3420-21	0.2540-12-0.3310-11	0.1230-06 0.1320-06	0.2110 00 0.7480 00	-0.0910-05 0.6500-05	73.6
89.417 -3.403	0.4380-02-0.2170-21	-0.1120-10-0.2410-13	0.1960-07 0.1800-07	0.1420 00 0.7650 00	-0.3620-06 0.1030-05	73.5
87.065 -1.715	0.4320-04-0.1540-24	-0.0280-10-0.2480-13	-0.4180-07-0.5290-07	0.1450 00 0.7640 00	-0.4640-03-0.1300-02	73.5
82.217 -1.046	0.1540-02-0.5770-01	0.3860-13-0.3070-12	0.7520-07 0.1020-06	0.1620 00 0.7600 00	-0.2620-05 0.1940-05	73.5
78.897 -1.346	0.1060-03-0.6320-25	-0.3360-09-0.9950-13	-0.1140-06-0.1870-06	0.1840 00 0.7550 00	-0.3980-03-0.1800-02	73.5
75.321 -1.382	0.1670-02-0.3410-21	0.2580-12-0.3250-11	0.1220-06 0.1310-06	0.2130 00 0.7570 00	-0.0900-05 0.6350-05	73.5
89.415 -3.390	0.4390-02-0.2180-21	-0.1050-10-0.2450-13	0.1900-07 0.1770-07	0.1440 00 0.7710 00	-0.3610-06 0.9980-06	73.4
87.033 -1.701	0.4200-04-0.1550-24	-0.0340-10-0.2500-13	-0.4190-07-0.5290-07	0.1480 00 0.7720 00	-0.4710-03-0.1320-02	73.4
82.190 -1.049	0.1550-02-0.5780-01	0.4100-13-0.3020-12	0.7560-07 0.1000-06	0.1640 00 0.7700 00	-0.2560-05 0.1930-05	73.4
78.864 -1.349	0.1040-03-0.6350-25	-0.3390-09-0.1030-09	-0.1110-06-0.1840-06	0.1860 00 0.7680 00	-0.1000-02-0.1820-02	73.4
75.285 -1.388	0.1680-02-0.3420-21	0.2610-12-0.3170-11	0.1160-06 0.1340-06	0.2160 00 0.7690 00	-0.0890-05 0.6170-05	73.4
89.411 -3.376	0.4400-02-0.2190-21	-0.0950-10-0.2490-13	0.1850-07 0.1750-07	0.1460 00 0.7800 00	-0.6050-06 0.9680-06	73.3
87.031 -1.687	0.4280-04-0.1560-24	-0.0400-10-0.2520-13	-0.4190-07-0.5290-07	0.1510 00 0.7800 00	-0.4910-03-0.1340-02	73.3
82.162 -1.052	0.1570-02-0.5780-01	0.4300-13-0.2960-12	0.7590-07 0.9930-07	0.1670 00 0.7780 00	-0.2550-05 0.1850-05	73.3
78.832 -1.350	0.1010-03-0.6360-25	-0.3410-09-0.1010-09	-0.1090-06-0.1820-06	0.1880 00 0.7770 00	-0.1020-02-0.1830-02	73.3
75.247 -1.394	0.1700-02-0.3430-21	0.2630-12-0.3100-11	0.1100-06 0.1300-06	0.2190 00 0.7780 00	-0.0870-05 0.6020-05	73.3
89.406 -3.359	0.4420-02-0.2200-21	-0.0930-10-0.2530-13	0.1840-07 0.1730-07	0.1480 00 0.7890 00	-0.5950-06 0.9410-06	73.1
80.968 -1.673	0.3970-04-0.1180-24	-0.0640-10-0.2540-13	-0.4190-07-0.5290-07	0.1530 00 0.7880 00	-0.5050-03-0.1350-02	73.1
82.135 -1.055	0.1580-02-0.5790-01	0.4440-13-0.2890-12	0.7620-07 0.9810-07	0.1700 00 0.7860 00	-0.2520-05 0.1810-05	73.1
78.800 -1.351	0.0940-04-0.2100-05	-0.3450-09-0.1010-09	-0.1060-06-0.1800-06	0.1920 00 0.7860 00	-0.1040-02-0.1850-02	73.1
75.210 -1.403	0.1710-02-0.3430-21	0.2650-12-0.3030-11	0.1060-06 0.1360-06	0.2210 00 0.7880 00	-0.0860-05 0.5860-05	73.1
89.402 -3.345	0.4430-02-0.2220-21	-0.0860-10-0.1980-13	0.1600-07 0.1710-07	0.1500 00 0.7970 00	-0.5870-06 0.9130-06	73.0
86.936 -1.660	0.3850-04-0.1110-24	-0.0650-10-0.2560-13	-0.4190-07-0.5290-07	0.1560 00 0.7970 00	-0.5190-03-0.1370-02	73.0
82.107 -1.056	0.1590-02-0.5790-01	0.4660-13-0.2830-12	0.7650-07 0.9700-07	0.1720 00 0.7950 00	-0.2480-05 0.1760-05	73.0
78.768 -1.353	0.0950-04-0.1160-05	-0.3460-09-0.1020-09	-0.1040-06-0.1780-06	0.1950 00 0.7950 00	-0.1060-02-0.1860-02	73.0
75.172 -1.406	0.1730-02-0.3430-21	0.2690-12-0.2960-11	0.1810-06 0.3030-06	0.2240 00 0.7970 00	-0.0830-05 0.5710-05	73.0

A = TOTAL CONVERSION COEFFICIENTS SLAB NUMBER = 1

J = 1	K = 1	A=	0.32025D 00	0.66861D 00
J = 1	K = 2	A=	-0.12022D-01	-0.50513D-01
J = 1	K = 3	A=	0.19543D-02	-0.57036D-03
J = 1	K = 4	A=	-0.62145D-03	0.20240D-02
J = 1	K = 5	A=	0.45805D-03	0.18273D-03
J = 2	K = 1	A=	-0.10261D-03	0.11601D-03
J = 2	K = 2	A=	-0.34110D 00	0.41504D 00
J = 2	K = 3	A=	0.15638D-04	-0.25860D-04
J = 2	K = 4	A=	0.81234D-03	-0.41084D-03
J = 2	K = 5	A=	0.61937D-05	0.16765D-05
J = 3	K = 1	A=	-0.39335D-02	0.19757D-02
J = 3	K = 2	A=	0.58883D-02	-0.78321D-03
J = 3	K = 3	A=	0.31032D 00	-0.79064D-01
J = 3	K = 4	A=	-0.24997D-02	-0.85621D-02
J = 3	K = 5	A=	-0.62846D-03	-0.11447D-03
J = 4	K = 1	A=	0.24376D-05	-0.16548D-05
J = 4	K = 2	A=	-0.25079D-02	-0.55898D-03
J = 4	K = 3	A=	-0.91930D-05	0.13526D-04
J = 4	K = 4	A=	-0.87304D-01	-0.10069D 00
J = 4	K = 5	A=	0.61099D-05	0.90252D-06
J = 5	K = 1	A=	-0.81859D-03	-0.83606D-03
J = 5	K = 2	A=	0.20984D-02	0.14098D-02
J = 5	K = 3	A=	0.66462D-03	0.37303D-03
J = 5	K = 4	A=	0.12152D-02	0.46009D-03
J = 5	K = 5	A=	-0.34434D-01	-0.49622D-01

A = TOTAL CONVERSION COEFFICIENTS SLAB NUMBER = 2

J = 1	K = 1	A=	0.39210D 00	-0.67747D 00
J = 1	K = 2	A=	-0.31125D-01	0.38872D-01
J = 1	K = 3	A=	-0.21433D-02	-0.17677D-02

J = 1	K = 4	A=	0.22119D-02	-0.11635D-02
J = 1	K = 5	A=	-0.10762D-03	-0.54839D-03
J = 2	K = 1	A=	0.14835D-03	0.35935D-05
J = 2	K = 2	A=	0.60193D 00	-0.73110D-01
J = 2	K = 3	A=	-0.34031D-04	0.16604D-04
J = 2	K = 4	A=	-0.84786D-03	0.25025D-04
J = 2	K = 5	A=	-0.51536D-05	-0.56192D-05
J = 3	K = 1	A=	0.69095D-02	0.15652D-02
J = 3	K = 2	A=	-0.78831D-02	-0.26392D-02
J = 3	K = 3	A=	-0.38760D 00	0.73188D-01
J = 3	K = 4	A=	0.35452D-02	0.12106D-01
J = 3	K = 5	A=	0.92573D-03	0.40657D-03
J = 4	K = 1	A=	-0.50274D-05	-0.29300D-05
J = 4	K = 2	A=	0.25393D-02	0.32505D-02
J = 4	K = 3	A=	0.10182D-04	-0.22528D-04
J = 4	K = 4	A=	0.19270D 00	0.25422D-01
J = 4	K = 5	A=	-0.77362D-05	-0.39013D-05
J = 5	K = 1	A=	-0.14762D-02	0.86429D-03
J = 5	K = 2	A=	0.15595D-02	-0.37714D-02
J = 5	K = 3	A=	-0.15121D-02	-0.13430D-02
J = 5	K = 4	A=	-0.29366D-02	0.10033D-02
J = 5	K = 5	A=	0.59296D-01	-0.81710D-01

A = TOTAL CONVERSION COEFFICIENTS SLAB NUMBER = 3

J = 1	K = 1	A=	0.74853D 00	-0.31601D 00
J = 1	K = 2	A=	-0.43443D-01	0.13812D-01
J = 1	K = 3	A=	-0.13717D-02	-0.31117D-02
J = 1	K = 4	A=	0.18503D-02	-0.13321D-03
J = 1	K = 5	A=	0.17119D-03	-0.44336D-03
J = 2	K = 1	A=	0.10774D-03	0.77762D-04
J = 2	K = 2	A=	0.60694D 00	0.24723D 00
J = 2	K = 3	A=	-0.40345D-04	0.67443D-05

J = 2	K = 4	A =	-0.318410-03	-0.330030-03
J = 2	K = 5	A =	-0.162890-06	-0.612650-05
J = 3	K = 1	A =	0.595910-02	0.578120-02
J = 3	K = 2	A =	-0.728360-02	-0.584410-02
J = 3	K = 3	A =	-0.448920 00	0.669860-01
J = 3	K = 4	A =	0.634190-02	0.141250-01
J = 3	K = 5	A =	0.122150-02	0.117200-03
J = 4	K = 1	A =	-0.301260-05	-0.561400-05
J = 4	K = 2	A =	0.284200-04	0.415570-02
J = 4	K = 3	A =	0.104710-04	-0.271990-04
J = 4	K = 4	A =	0.233990 00	-0.867150-01
J = 4	K = 5	A =	-0.234640-04	0.183840-05
J = 5	K = 1	A =	-0.176610-02	0.830280-04
J = 5	K = 2	A =	0.300370-02	-0.279150-02
J = 5	K = 3	A =	-0.164730-02	-0.156700-02
J = 5	K = 4	A =	-0.375260-02	0.324860-02
J = 5	K = 5	A =	-0.866010-01	-0.113360 00

A = TOTAL CONVERSION COEFFICIENTS SLAB NUMBER = 4

J = 1	K = 1	A =	0.817960 00	0.205590 00
J = 1	K = 2	A =	-0.390130-01	-0.108330-01
J = 1	K = 3	A =	0.603060-06	-0.385680-02
J = 1	K = 4	A =	0.630000-03	0.739180-03
J = 1	K = 5	A =	0.447470-03	-0.120180-03
J = 2	K = 1	A =	0.393900-04	0.108450-03
J = 2	K = 2	A =	0.444420 00	0.550940 00
J = 2	K = 3	A =	-0.413720-04	-0.473950-05
J = 2	K = 4	A =	0.445250-03	-0.626480-03
J = 2	K = 5	A =	0.571540-05	-0.730860-05
J = 3	K = 1	A =	0.287870-02	0.879550-02
J = 3	K = 2	A =	-0.477640-02	-0.833040-02

J = 3	K = 3	A =	-0.519400 00	0.591320-01
J = 3	K = 4	A =	0.987140-02	0.153110-01
J = 3	K = 5	A =	0.936200-03	-0.283090-03
J = 4	K = 1	A =	-0.441160-08	-0.576080-05
J = 4	K = 2	A =	-0.294730-02	0.427090-02
J = 4	K = 3	A =	0.901010-05	-0.317060-04
J = 4	K = 4	A =	0.211950 00	-0.240780 00
J = 4	K = 5	A =	-0.281930-04	0.332830-04
J = 5	K = 1	A =	-0.122580-02	-0.723040-03
J = 5	K = 2	A =	0.408570-02	-0.268410-03
J = 5	K = 3	A =	-0.187650-02	-0.180590-02
J = 5	K = 4	A =	-0.173840-02	0.726160-02
J = 5	K = 5	A =	-0.188290 00	0.732630-01

A = TOTAL CONVERSION COEFFICIENTS SLAB NUMBER = 5

J = 1	K = 1	A =	0.550330 00	0.661000 00
J = 1	K = 2	A =	-0.227360-01	-0.259730-01
J = 1	K = 3	A =	0.147920-02	-0.368150-02
J = 1	K = 4	A =	-0.125030-02	0.134590-02
J = 1	K = 5	A =	0.625560-03	0.150820-03
J = 2	K = 1	A =	-0.234090-04	0.931160-04
J = 2	K = 2	A =	0.133630 00	0.753360 00
J = 2	K = 3	A =	-0.371950-04	-0.148780-04
J = 2	K = 4	A =	0.127050-02	-0.918450-03
J = 2	K = 5	A =	0.781750-05	-0.807540-05
J = 3	K = 1	A =	-0.133100-02	0.939900-02
J = 3	K = 2	A =	-0.187860-02	-0.940590-02
J = 3	K = 3	A =	-0.600690 00	0.494270-01
J = 3	K = 4	A =	0.136830-01	0.142790-01
J = 3	K = 5	A =	0.292200-03	0.142670-03
J = 4	K = 1	A =	0.254360-05	-0.357080-05
J = 4	K = 2	A =	-0.574750-02	0.311790-02

J = 4	K = 3	A=	0.53667D-05	-0.34550D-04
J = 4	K = 4	A=	0.91069D-01	-0.40251D 00
J = 4	K = 5	A=	0.97661D-05	0.64378D-04
J = 5	K = 1	A=	0.15483D-03	-0.17099D-02
J = 5	K = 2	A=	0.51266D-02	0.20225D-02
J = 5	K = 3	A=	-0.19122D-02	-0.21801D-02
J = 5	K = 4	A=	0.45141D-02	0.91488D-02
J = 5	K = 5	A=	0.28367D-01	0.26557D 00
A = TOTAL CONVERSION COEFFICIENTS			SLAB NUMBER = 6	
J = 1	K = 1	A=	0.32346D-01	0.90607D 00
J = 1	K = 2	A=	-0.41123D-02	-0.27384D-01
J = 1	K = 3	A=	0.24615D-02	-0.27811D-02
J = 1	K = 4	A=	-0.31420D-02	0.15115D-02
J = 1	K = 5	A=	0.45834D-03	0.23819D-03
J = 2	K = 1	A=	-0.57262D-04	0.48745D-04
J = 2	K = 2	A=	-0.26414D 00	0.76363D 00
J = 2	K = 3	A=	-0.28566D-04	-0.21047D-04
J = 2	K = 4	A=	0.19570D-02	-0.11838D-02
J = 2	K = 5	A=	0.49045D-05	-0.34485D-05
J = 3	K = 1	A=	-0.45438D-02	0.76983D-02
J = 3	K = 2	A=	0.11689D-02	-0.84165D-02
J = 3	K = 3	A=	-0.69449D 00	0.37962D-01
J = 3	K = 4	A=	0.16446D-01	0.10860D-01
J = 3	K = 5	A=	0.61055D-03	0.13188D-02
J = 4	K = 1	A=	0.49300D-05	0.66709D-06
J = 4	K = 2	A=	-0.76319D-02	0.13697D-02
J = 4	K = 3	A=	0.52563D-06	-0.33505D-04
J = 4	K = 4	A=	-0.14827D 00	-0.51006D 00
J = 4	K = 5	A=	0.71846D-04	0.39197D-04
J = 5	K = 1	A=	0.58785D-03	-0.22668D-02

J = 5	K = 2	A =	0.43634D-02	0.30987D-02
J = 5	K = 3	A =	-0.22908D-02	-0.27356D-02
J = 5	K = 4	A =	0.11251D-01	0.48889D-02
J = 5	K = 5	A =	0.40306D 00	0.66700D-01
A = TOTAL CONVERSION COEFFICIENTS			SLAB NUMBER = 7	
J = 1	K = 1	A =	-0.53858D 00	0.77454D 00
J = 1	K = 2	A =	0.80052D-02	-0.17977D-01
J = 1	K = 3	A =	0.25998D-02	-0.15262D-02
J = 1	K = 4	A =	-0.41633D-02	0.14959D-02
J = 1	K = 5	A =	-0.12169D-03	0.32831D-03
J = 2	K = 1	A =	-0.51933D-04	0.50590D-05
J = 2	K = 2	A =	-0.65604D 00	0.60739D 00
J = 2	K = 3	A =	-0.17761D-04	-0.20988D-04
J = 2	K = 4	A =	0.21134D-02	-0.13454D-02
J = 2	K = 5	A =	0.38928D-05	0.74447D-05
J = 3	K = 1	A =	-0.58830D-02	0.43230D-02
J = 3	K = 2	A =	0.30027D-02	-0.61111D-02
J = 3	K = 3	A =	-0.80317D 00	0.24601D-01
J = 3	K = 4	A =	0.16254D-01	0.54558D-02
J = 3	K = 5	A =	0.23719D-02	0.14843D-02
J = 4	K = 1	A =	0.44381D-05	0.42002D-05
J = 4	K = 2	A =	-0.74783D-02	-0.85094D-03
J = 4	K = 3	A =	-0.32726D-05	-0.28677D-04
J = 4	K = 4	A =	-0.48875D 00	-0.47946D 00
J = 4	K = 5	A =	0.78476D-04	-0.39266D-04
J = 5	K = 1	A =	0.73995D-03	-0.96209D-03
J = 5	K = 2	A =	0.10315D-02	0.36316D-02
J = 5	K = 3	A =	-0.26318D-02	-0.32057D-02
J = 5	K = 4	A =	0.12206D-01	-0.40886D-02
J = 5	K = 5	A =	0.23669D 00	-0.53308D 00
A = TOTAL CONVERSION COEFFICIENTS			SLAB NUMBER = 8	

J = 1	K = 1	A=	0.997080 00	0.206320-03
J = 1	K = 2	A=	-0.104270-01	0.314820-02
J = 1	K = 3	A=	-0.190520-02	0.199060-04
J = 1	K = 4	A=	0.427380-02	-0.145220-03
J = 1	K = 5	A=	0.833370-03	-0.383280-03
J = 2	K = 1	A=	0.209130-04	0.188540-04
J = 2	K = 2	A=	0.101020 01	-0.468240-02
J = 2	K = 3	A=	0.496920-05	0.162880-04
J = 2	K = 4	A=	-0.198910-02	0.798070-03
J = 2	K = 5	A=	-0.639060-05	-0.170560-04
J = 3	K = 1	A=	0.445150-02	-0.265360-03
J = 3	K = 2	A=	-0.321030-02	0.256260-02
J = 3	K = 3	A=	0.998440 00	-0.556770-03
J = 3	K = 4	A=	-0.130080-01	0.447650-03
J = 3	K = 5	A=	-0.361720-02	0.733230-03
J = 4	K = 1	A=	-0.360870-05	-0.416340-05
J = 4	K = 2	A=	0.666980-02	0.160700-02
J = 4	K = 3	A=	0.893460-05	0.184980-04
J = 4	K = 4	A=	0.100680 01	-0.600810-02
J = 4	K = 5	A=	0.189900-04	0.800020-04
J = 5	K = 1	A=	-0.285520-02	0.447270-04
J = 5	K = 2	A=	-0.454270-03	-0.809120-02
J = 5	K = 3	A=	0.565470-02	0.922370-03
J = 5	K = 4	A=	0.120200-02	0.124380-01
J = 5	K = 5	A=	0.997360 00	-0.172760-02

A = TOTAL CONVERSION COEFFICIENTS SLAB NUMBER = 9

J = 1	K = 1	A=	0.100000 01	0.0
J = 1	K = 2	A=	0.0	0.0
J = 1	K = 3	A=	0.0	0.0
J = 1	K = 4	A=	0.0	0.0

J = 1	K = 5	A=	0.0	0.0
J = 2	K = 1	A=	0.0	0.0
J = 2	K = 2	A=	0.100000 01	0.0
J = 2	K = 3	A=	0.0	0.0
J = 2	K = 4	A=	0.0	0.0
J = 2	K = 5	A=	0.0	0.0
J = 3	K = 1	A=	0.0	0.0
J = 3	K = 2	A=	0.0	0.0
J = 3	K = 3	A=	0.100000 01	0.0
J = 3	K = 4	A=	0.0	0.0
J = 3	K = 5	A=	0.0	0.0
J = 4	K = 1	A=	0.0	0.0
J = 4	K = 2	A=	0.0	0.0
J = 4	K = 3	A=	0.0	0.0
J = 4	K = 4	A=	0.100000 01	0.0
J = 4	K = 5	A=	0.0	0.0
J = 5	K = 1	A=	0.0	0.0
J = 5	K = 2	A=	0.0	0.0
J = 5	K = 3	A=	0.0	0.0
J = 5	K = 4	A=	0.0	0.0
J = 5	K = 5	A=	0.100000 01	0.0

ELECTRIC FIELD STRENGTH AS A FUNCTION OF RHO

GAMMA(DEG)= 0.0 PHI(DEG)= 0.0 ZT(KM)= 5.000 ZR(KM)= 10.000								
Z			X			Y		
RHO(KM)	AMP(DB)	ANG(DEG)	RHO(KM)	AMP(DB)	ANG(DEG)	RHO(KM)	AMP(DB)	ANG(DEG)
25.00	76.29234	263.2688	25.00	59.90491	152.2287	25.00	41.45424	238.2237
50.00	72.98376	257.5801	50.00	56.25769	135.7691	50.00	37.85649	212.8739
75.00	70.78876	252.3931	75.00	53.75735	119.4766	75.00	35.51668	187.0150
100.00	68.98273	247.8470	100.00	51.61769	103.3704	100.00	33.77069	161.0755
125.00	67.35411	244.0912	125.00	49.58498	87.3927	125.00	32.39372	135.1018
150.00	65.82755	241.2690	150.00	47.52316	71.4682	150.00	31.28989	109.1563
175.00	64.38651	239.4891	175.00	45.32722	55.4832	175.00	30.41103	83.3227
200.00	63.04761	238.7764	200.00	42.88458	39.2385	200.00	29.72945	57.7085
225.00	61.84721	239.0170	225.00	40.02911	23.0221	225.00	29.16455	33.4116
250.00	60.81107	239.8885	250.00	36.53989	4.6606	250.00	28.83185	8.5596
275.00	59.95270	240.9785	275.00	31.84071	341.5400	275.00	28.64261	344.3625
300.00	59.25110	241.8292	300.00	25.12791	297.7227	300.00	28.57390	320.9485
325.00	58.65680	242.0927	325.00	24.67183	209.2661	325.00	28.60027	298.4187
350.00	58.10954	241.5722	350.00	29.65506	166.0424	350.00	28.57823	276.8586
375.00	57.54008	240.3263	375.00	32.82829	144.7204	375.00	28.73222	256.3191
400.00	56.90408	238.4413	400.00	34.76332	127.9352	400.00	28.90077	236.7713
425.00	56.16014	236.0790	425.00	35.99524	112.9103	425.00	29.06299	218.1858
450.00	55.27319	233.4316	450.00	36.76811	98.8009	450.00	29.20108	200.5223
475.00	54.20961	230.6798	475.00	37.23258	84.8595	475.00	29.28441	183.4644
500.00	52.93156	228.1687	500.00	37.36682	71.8263	500.00	29.33116	167.5499
525.00	51.39867	226.2026	525.00	37.31810	59.1317	525.00	29.31720	152.4182
550.00	49.55347	225.3099	550.00	37.08209	46.7381	550.00	29.23508	138.0355
575.00	47.32220	226.4329	575.00	36.67429	34.6322	575.00	29.07872	124.3776
600.00	44.63403	231.4045	600.00	36.13287	22.7550	600.00	28.88341	111.2962
625.00	41.63359	244.3454	625.00	35.39761	11.2109	625.00	28.55882	99.0160
650.00	39.46725	269.7253	650.00	34.49896	0.0290	650.00	28.14732	87.4632
675.00	39.95416	298.2769	675.00	33.42958	349.2854	675.00	27.64759	76.6715
700.00	41.94011	315.4939	700.00	32.17734	339.1038	700.00	27.05814	66.6955
725.00	43.81900	323.6453	725.00	30.79295	330.0586	725.00	26.44009	57.7078
750.00	45.29208	327.3501	750.00	29.14931	321.5710	750.00	25.68810	49.5037
775.00	46.39511	329.0024	775.00	27.26694	314.6301	775.00	24.86755	42.4046
800.00	47.21843	329.7319	800.00	25.14587	310.1309	800.00	24.00182	36.5465
825.00	47.83922	330.0955	825.00	22.87070	309.5276	825.00	23.12830	32.0445
850.00	48.31659	330.4138	850.00	21.01863	315.1108	850.00	22.36522	29.1504
875.00	48.70630	330.7258	875.00	19.80577	323.9875	875.00	21.65184	27.1271
900.00	49.03757	331.0835	900.00	19.75130	332.7961	900.00	21.09418	26.0126
925.00	49.33565	331.4578	925.00	20.46809	336.9707	925.00	20.72151	25.3085
950.00	49.61635	331.7844	950.00	21.36862	336.0334	950.00	20.52293	24.4713
975.00	49.88675	331.9897	975.00	22.15694	331.3999	975.00	20.45189	23.0804
1000.00	50.14691	332.0081	1000.00	22.75043	324.3645	1000.00	20.44556	20.9269
1025.00	50.39211	331.7952	1025.00	23.14766	315.7686	1025.00	20.44417	17.9951
1050.00	50.61794	331.3523	1050.00	23.42491	306.0242	1050.00	20.44395	14.5671
1075.00	50.81192	330.6411	1075.00	23.48744	295.5928	1075.00	20.33031	10.3539
1100.00	50.96849	329.7109	1100.00	23.42499	284.6973	1100.00	20.11635	5.8188
1125.00	51.08234	328.6028	1125.00	23.25829	273.4995	1125.00	19.78918	1.1468
1150.00	51.15012	327.3650	1150.00	23.00464	262.1365	1150.00	19.34108	356.5193
1175.00	51.17041	326.0486	1175.00	22.67813	250.7361	1175.00	18.76810	352.1216
1200.00	51.14354	324.7034	1200.00	22.28987	239.4254	1200.00	18.07005	348.1531
1225.00	51.07132	323.3752	1225.00	21.84828	228.3357	1225.00	17.25197	344.8381
1250.00	50.95685	322.1050	1250.00	21.35965	217.6042	1250.00	16.32759	342.4343
1275.00	50.80411	320.9265	1275.00	20.82889	207.3739	1275.00	15.32566	341.2273
1300.00	50.61781	319.8655	1300.00	20.26102	197.7929	1300.00	14.29841	341.4915
1325.00	50.40297	318.9390	1325.00	19.66304	189.0123	1325.00	13.32873	343.3853
1350.00	50.16458	318.1558	1350.00	19.04646	181.1795	1350.00	12.52348	346.7732

1375.00	49.90724	317.5159
1400.00	49.63486	317.0127
1425.00	49.35028	316.6345
1450.00	49.05519	316.3669
1475.00	48.75000	316.1960
1500.00	48.43399	316.1116
1525.00	48.10559	316.1091
1550.00	47.76273	316.1919
1575.00	47.40327	316.3713
1600.00	47.02544	316.6677
1625.00	46.62828	317.1091
1650.00	46.21207	317.7302
1675.00	45.77864	318.5693
1700.00	45.33167	319.6663
1725.00	44.87686	321.0579
1750.00	44.42197	322.7742
1775.00	43.97664	324.8335
1800.00	43.55182	327.2371
1825.00	43.15898	329.9651
1850.00	42.80888	332.9751
1875.00	42.51033	336.2039
1900.00	42.26901	339.5735
1925.00	42.08691	342.9993
1950.00	41.96231	346.4006
1975.00	41.89052	349.7078
2000.00	41.86484	352.8669
2025.00	41.87776	355.8413
2050.00	41.92177	358.6086
2075.00	41.98990	1.1592
2100.00	42.07603	3.4903
2125.00	42.17485	5.6049
2150.00	42.28177	7.5088
2175.00	42.39275	9.2096
2200.00	42.50415	10.7162
2225.00	42.61272	12.0391
2250.00	42.71545	13.1898
2275.00	42.80971	14.1817
2300.00	42.89316	15.0291
2325.00	42.96381	15.7479
2350.00	43.02008	16.3544
2375.00	43.06079	16.8655
2400.00	43.08517	17.2981
2425.00	43.09276	17.6685
2450.00	43.08350	17.9922
2475.00	43.05756	18.2836
2500.00	43.01535	18.5556
2525.00	42.95746	18.8200
2550.00	42.88458	19.0869
2575.00	42.79747	19.3650
2600.00	42.69690	19.6620
2625.00	42.58363	19.9846
2650.00	42.45836	20.3388
2675.00	42.32181	20.7302
2700.00	42.17461	21.1640
2725.00	42.01743	21.6455
2750.00	41.85091	22.1802
2775.00	41.67580	22.7736
2800.00	41.49289	23.4313
2825.00	41.30309	24.1590
2850.00	41.10747	24.9621
2875.00	40.90723	25.8456

1375.00	18.43004	174.4257
1400.00	17.84206	168.8399
1425.00	17.32025	164.4294
1450.00	16.90714	161.0745
1475.00	16.63916	158.5040
1500.00	16.53325	156.3272
1525.00	16.57874	154.1279
1550.00	16.74065	151.5716
1575.00	16.97197	148.4663
1600.00	17.22643	144.7589
1625.00	17.46609	140.4926
1650.00	17.66344	135.7619
1675.00	17.80031	130.6794
1700.00	17.86580	125.3573
1725.00	17.85414	119.8995
1750.00	17.76328	114.3994
1775.00	17.59373	108.9400
1800.00	17.34813	103.5956
1825.00	17.03081	98.4320
1850.00	16.64783	93.5071
1875.00	16.20694	88.4699
1900.00	15.71765	84.5577
1925.00	15.19106	80.5925
1950.00	14.63950	76.9758
1975.00	14.07575	73.6839
2000.00	13.51171	70.6646
2025.00	12.95681	67.8374
2050.00	12.41643	65.0991
2075.00	11.89073	62.3342
2100.00	11.37442	59.4272
2125.00	10.85737	56.2744
2150.00	10.32607	52.7906
2175.00	9.76520	48.9110
2200.00	9.15905	44.5863
2225.00	8.49265	39.7748
2250.00	7.75243	34.4323
2275.00	6.92681	28.4496
2300.00	6.00704	21.8882
2325.00	4.98885	14.4642
2350.00	3.87602	6.0301
2375.00	2.68745	356.3123
2400.00	1.46979	344.9751
2425.00	0.31462	351.7158
2450.00	-0.63272	316.5171
2475.00	-1.20742	300.0037
2500.00	-1.31864	283.4971
2525.00	-1.01906	268.3994
2550.00	-0.45701	255.4790
2575.00	0.22197	244.7899
2600.00	0.92247	236.0135
2625.00	1.59561	228.7473
2650.00	2.22134	222.6308
2675.00	2.79415	217.3746
2700.00	3.31464	212.7543
2725.00	3.78530	208.5988
2750.00	4.20851	204.7787
2775.00	4.58593	201.1976
2800.00	4.91838	197.7858
2825.00	5.20608	194.4948
2850.00	5.44893	191.2934
2875.00	5.64677	188.1634

1375.00	11.97878	351.0781
1400.00	11.72717	355.3843
1425.00	11.71518	358.8298
1450.00	11.83764	0.9493
1475.00	11.98946	1.7006
1500.00	12.09305	1.2926
1525.00	12.10005	0.0219
1550.00	11.98307	358.1875
1575.00	11.72742	356.0647
1600.00	11.32553	353.9082
1625.00	10.77408	351.9678
1650.00	10.07345	350.5076
1675.00	9.22959	349.8293
1700.00	8.25928	350.2927
1725.00	7.20053	352.3196
1750.00	6.12912	356.3398
1775.00	5.17413	2.6043
1800.00	4.50492	10.8328
1825.00	4.25525	19.9726
1850.00	4.42739	28.5775
1875.00	4.89522	35.6199
1900.00	5.50215	40.8360
1925.00	6.13425	44.4632
1950.00	6.73100	46.8907
1975.00	7.26907	48.4757
2000.00	7.74556	49.4885
2025.00	8.16704	50.1131
2050.00	8.54330	50.4632
2075.00	8.88384	50.6000
2100.00	9.19609	50.5491
2125.00	9.48461	50.3149
2150.00	9.75109	49.8925
2175.00	9.99476	49.2767
2200.00	10.21315	48.4675
2225.00	10.40284	47.4735
2250.00	10.56021	46.3120
2275.00	10.68198	45.0079
2300.00	10.76501	43.5922
2325.00	10.80947	42.0998
2350.00	10.81299	40.5675
2375.00	10.77662	39.0319
2400.00	10.70183	37.5284
2425.00	10.59095	36.0892
2450.00	10.44716	34.7426
2475.00	10.27423	33.5115
2500.00	10.07642	32.4131
2525.00	9.85818	31.4578
2550.00	9.62397	30.6491
2575.00	9.37792	29.9841
2600.00	9.12360	29.4539
2625.00	8.86379	29.0456
2650.00	8.60033	28.7436
2675.00	8.33408	28.5320
2700.00	8.06500	28.3969
2725.00	7.79233	28.3277
2750.00	7.51482	28.3186
2775.00	7.23103	28.3695
2800.00	6.93965	28.4852
2825.00	6.63970	28.6751
2850.00	6.33079	28.9524
2875.00	6.01319	29.3320

2900.00	40.70374	26.6138
2925.00	40.49852	27.8700
2950.00	40.29324	29.0162
2975.00	40.08963	30.2526
3000.00	39.88948	31.5780
3025.00	39.69460	32.9891
3050.00	39.50665	34.4807
3075.00	39.32729	36.0459
3100.00	39.15790	37.6760
3125.00	38.99965	39.3611
3150.00	38.85349	41.0900
3175.00	38.72003	42.8511
3200.00	38.59964	44.6323
3225.00	38.49236	46.4214
3250.00	38.39798	48.2068
3275.00	38.31601	49.9774
3300.00	38.24576	51.7229
3325.00	38.18633	53.4342
3350.00	38.13667	55.1034
3375.00	38.09560	56.7238
3400.00	38.06183	58.2901
3425.00	38.03407	59.7984
3450.00	38.01096	61.2461
3475.00	37.99115	62.6319
3500.00	37.97336	63.9559
3525.00	37.95636	65.2191
3550.00	37.93900	66.4237
3575.00	37.92023	67.5724
3600.00	37.89912	68.6690
3625.00	37.87485	69.7177
3650.00	37.84671	70.7229
3675.00	37.81412	71.6896
3700.00	37.77664	72.6228
3725.00	37.73387	73.5275
3750.00	37.68559	74.4087
3775.00	37.63161	75.2713
3800.00	37.57182	76.1203
3825.00	37.50623	76.9603
3850.00	37.43486	77.7956
3875.00	37.35782	78.6306
3900.00	37.27530	79.4693
3925.00	37.18745	80.3156
3950.00	37.09459	81.1732
3975.00	36.99698	82.0454
4000.00	36.89497	82.9355
4025.00	36.78897	83.8463
4050.00	36.67938	84.7805
4075.00	36.56668	85.7404
4100.00	36.45135	86.7279
4125.00	36.33394	87.7447
4150.00	36.21500	88.7919
4175.00	36.09506	89.8703
4200.00	35.97473	90.9802
4225.00	35.85457	92.1216
4250.00	35.73515	93.2936
4275.00	35.61702	94.4955
4300.00	35.50069	95.7255
4325.00	35.38664	96.9819
4350.00	35.27534	98.2623
4375.00	35.16716	99.5642
4400.00	35.06244	100.8847

2900.00	5.79960	185.0970
2925.00	5.90771	182.0933
2950.00	5.97176	179.1567
2975.00	5.99279	176.2943
3000.00	5.97223	173.5148
3025.00	5.91181	170.8268
3050.00	5.81353	168.2382
3075.00	5.67950	165.7551
3100.00	5.51188	163.3814
3125.00	5.31270	161.1188
3150.00	5.08378	158.9663
3175.00	4.82655	156.9210
3200.00	4.54195	154.9783
3225.00	4.23035	153.1330
3250.00	3.89143	151.3801
3275.00	3.52421	149.7159
3300.00	3.12703	148.1391
3325.00	2.69756	146.6521
3350.00	2.23290	145.2624
3375.00	1.72963	143.9830
3400.00	1.18389	142.8343
3425.00	0.59149	141.8452
3450.00	-0.05201	141.0548
3475.00	-0.75115	140.5147
3500.00	-1.51041	140.2428
3525.00	-2.33375	140.4774
3550.00	-3.22392	141.1843
3575.00	-4.18100	142.5648
3600.00	-5.19974	144.8158
3625.00	-6.26458	148.1853
3650.00	-7.34159	152.9622
3675.00	-8.36735	159.4207
3700.00	-9.24117	167.6756
3725.00	-9.83776	177.4518
3750.00	-10.05761	187.9402
3775.00	-9.88961	198.0253
3800.00	-9.41850	208.8054
3825.00	-8.76787	213.9015
3850.00	-8.04357	219.3659
3875.00	-7.31455	223.4476
3900.00	-6.61859	226.4289
3925.00	-5.97347	228.5564
3950.00	-5.38582	230.0253
3975.00	-4.85659	230.9846
4000.00	-4.38403	231.5467
4025.00	-3.96529	231.7970
4050.00	-3.59719	231.8010
4075.00	-3.27660	231.6102
4100.00	-3.00057	231.2656
4125.00	-2.76641	230.8006
4150.00	-2.57164	230.2429
4175.00	-2.41403	229.6157
4200.00	-2.29151	228.9391
4225.00	-2.20218	228.2301
4250.00	-2.14431	227.5036
4275.00	-2.11628	226.7727
4300.00	-2.11662	226.0488
4325.00	-2.14399	225.3421
4350.00	-2.19715	224.6620
4375.00	-2.27500	224.0169
4400.00	-2.37655	223.4149

2900.00	5.68795	29.8293
2925.00	5.35685	30.4591
2950.00	5.02233	31.2332
2975.00	4.68733	32.1600
3000.00	4.35516	33.2438
3025.00	4.02926	34.4837
3050.00	3.71298	35.8744
3075.00	3.40945	37.4064
3100.00	3.12143	39.0668
3125.00	2.85125	40.8406
3150.00	2.60083	42.7110
3175.00	2.37170	44.6606
3200.00	2.16511	46.6711
3225.00	1.98202	48.7237
3250.00	1.82314	50.7984
3275.00	1.68885	52.8740
3300.00	1.57913	54.9277
3325.00	1.49341	56.9361
3350.00	1.43047	58.8750
3375.00	1.38838	60.7217
3400.00	1.36452	62.4553
3425.00	1.35563	64.0590
3450.00	1.35875	65.5201
3475.00	1.36783	66.8315
3500.00	1.38103	67.9913
3525.00	1.39384	69.0025
3550.00	1.40282	69.8723
3575.00	1.40491	70.6114
3600.00	1.39760	71.2328
3625.00	1.37885	71.7512
3650.00	1.34713	72.1819
3675.00	1.30136	72.5401
3700.00	1.24086	72.8407
3725.00	1.16527	73.0975
3750.00	1.07449	73.3237
3775.00	0.96860	73.5307
3800.00	0.84784	73.7294
3825.00	0.71252	73.9293
3850.00	0.56300	74.1390
3875.00	0.39908	74.3667
3900.00	0.22295	74.6199
3925.00	0.03322	74.9058
3950.00	-0.16907	75.2316
3975.00	-0.38346	75.6044
4000.00	-0.60943	76.0315
4025.00	-0.84639	76.5201
4050.00	-1.09367	77.0776
4075.00	-1.35044	77.7114
4100.00	-1.61578	78.4286
4125.00	-1.88860	79.2362
4150.00	-2.16765	80.1405
4175.00	-2.45157	81.1474
4200.00	-2.73881	82.2617
4225.00	-3.02770	83.4873
4250.00	-3.31646	84.8268
4275.00	-3.60322	86.2815
4300.00	-3.88601	87.8513
4325.00	-4.16286	89.5342
4350.00	-4.43174	91.3267
4375.00	-4.69067	93.2233
4400.00	-4.93775	95.2167

4425.00 34.96144 102.2206
 4450.00 34.86435 103.5687
 4475.00 34.77133 104.9256
 4500.00 34.68243 106.2878
 4525.00 34.59766 107.6520
 4550.00 34.51692 109.0148
 4575.00 34.44011 110.3732
 4600.00 34.36702 111.7242
 4625.00 34.29739 113.0650
 4650.00 34.23094 114.3933
 4675.00 34.16736 115.7069
 4700.00 34.10628 117.0042
 4725.00 34.04732 118.2838
 4750.00 33.99007 119.5446
 4775.00 33.93416 120.7859
 4800.00 33.87918 122.0076
 4825.00 33.82475 123.2096
 4850.00 33.77051 124.3922
 4875.00 33.71609 125.5560
 4900.00 33.66118 126.7020
 4925.00 33.60547 127.8311
 4950.00 33.54869 128.9447
 4975.00 33.49063 130.0441
 5000.00 33.43106 131.1310

4425.00 -2.50092 222.8635
 4450.00 -2.64732 222.3707
 4475.00 -2.81501 221.9443
 4500.00 -3.00334 221.5926
 4525.00 -3.21163 221.3245
 4550.00 -3.43921 221.1497
 4575.00 -3.68533 221.0787
 4600.00 -3.94911 221.1229
 4625.00 -4.22952 221.2946
 4650.00 -4.52529 221.6068
 4675.00 -4.83484 222.0733
 4700.00 -5.15623 222.7082
 4725.00 -5.48709 223.5254
 4750.00 -5.82455 224.5383
 4775.00 -6.16520 225.7589
 4800.00 -6.50906 227.1968
 4825.00 -6.83957 228.8579
 4850.00 -7.16370 230.7437
 4875.00 -7.47201 232.8490
 4900.00 -7.75894 235.1617
 4925.00 -8.01902 237.6612
 4950.00 -8.24731 240.3186
 4975.00 -8.43973 243.0973
 5000.00 -8.59344 245.9544

4425.00 -5.17118 97.2974
 4450.00 -5.38934 99.4544
 4475.00 -5.59084 101.6745
 4500.00 -5.77458 103.9431
 4525.00 -5.93983 106.2442
 4550.00 -6.08622 108.5613
 4575.00 -6.21386 110.8772
 4600.00 -6.32326 113.1753
 4625.00 -6.41538 115.4398
 4650.00 -6.49154 117.6564
 4675.00 -6.55340 119.8128
 4700.00 -6.60286 121.8992
 4725.00 -6.64196 123.9081
 4750.00 -6.67286 125.8348
 4775.00 -6.69765 127.6768
 4800.00 -6.71840 129.4343
 4825.00 -6.73702 131.1090
 4850.00 -6.75527 132.7048
 4875.00 -6.77470 134.2265
 4900.00 -6.79666 135.6802
 4925.00 -6.82231 137.0728
 4950.00 -6.85258 138.4115
 4975.00 -6.88822 139.7039
 5000.00 -6.92982 140.9578

GAMMA(DEG) = 90.0 PHI(DEG) = 0.0 ZT(KM) = 5.000 ZR(KM) = 10.000

Z
 RHO(KM) AMP(DB) ANG(DEG)
 25.00 50.12587 339.2913
 50.00 46.62431 323.8484
 75.00 44.24646 308.7957
 100.00 42.23627 294.1172
 125.00 40.34470 279.8438
 150.00 38.44202 266.0344
 175.00 36.43317 252.7946
 200.00 34.22368 240.3182
 225.00 31.68236 229.0578
 250.00 28.65649 219.7790
 275.00 24.82620 214.9024
 300.00 19.89055 222.6733
 325.00 16.80251 261.1855
 350.00 20.08025 289.5637
 375.00 23.30537 292.2336
 400.00 25.45798 286.6638
 425.00 26.88760 278.2070
 450.00 27.83131 268.5425
 475.00 28.42650 258.3020
 500.00 28.74255 247.8815
 525.00 28.83633 237.4101
 550.00 28.73862 226.9955
 575.00 28.46931 216.7173
 600.00 28.04149 206.6302
 625.00 27.46289 196.8406
 650.00 26.73857 187.4042
 675.00 25.87073 178.4198
 700.00 24.86089 170.0174
 725.00 23.71315 162.3765
 750.00 22.43643 155.7158
 775.00 21.05009 150.3474
 800.00 19.60046 146.6409
 825.00 18.17712 144.9353

X
 RHO(KM) AMP(DB) ANG(DEG)
 25.00 42.71786 228.9590
 50.00 39.01591 209.3819
 75.00 36.54716 189.7149
 100.00 34.51863 169.9487
 125.00 32.69846 149.9716
 150.00 30.98608 129.6560
 175.00 29.33362 108.8566
 200.00 27.72240 87.4131
 225.00 26.08528 65.4363
 250.00 24.59290 42.3459
 275.00 23.21300 18.2811
 300.00 22.00006 353.3696
 325.00 21.00266 327.9573
 350.00 20.14536 302.6050
 375.00 19.60426 277.8572
 400.00 19.22394 254.3666
 425.00 18.93776 231.4101
 450.00 18.68539 209.8826
 475.00 18.37082 189.2922
 500.00 18.06393 169.7370
 525.00 17.69263 150.8935
 550.00 17.24289 132.6246
 575.00 16.70468 114.8108
 600.00 16.03992 97.4098
 625.00 15.30481 80.2623
 650.00 14.45802 63.2791
 675.00 13.48899 46.3686
 700.00 12.38424 29.4257
 725.00 11.10239 12.6022
 750.00 9.67964 355.2122
 775.00 8.05382 337.1929
 800.00 6.18925 318.0837
 825.00 4.05174 297.0745

Y
 RHO(KM) AMP(DB) ANG(DEG)
 25.00 28.16039 316.5537
 50.00 24.54335 292.3921
 75.00 22.21384 267.8088
 100.00 20.46371 243.2106
 125.00 19.06551 218.6546
 150.00 17.91919 194.2121
 175.00 16.97090 169.9683
 200.00 16.18588 146.0188
 225.00 15.51073 122.9182
 250.00 14.98362 99.8135
 275.00 14.54688 77.2719
 300.00 14.17793 55.3418
 325.00 13.85535 34.0494
 350.00 13.52044 13.5921
 375.00 13.24250 353.5791
 400.00 12.95739 334.1758
 425.00 12.65184 315.3464
 450.00 12.31454 297.0525
 475.00 11.92619 279.3635
 500.00 11.50248 262.0205
 525.00 11.02089 245.0972
 550.00 10.47436 228.5589
 575.00 9.85599 212.3753
 600.00 9.16008 196.5747
 625.00 8.37870 181.0140
 650.00 7.50127 165.7384
 675.00 6.51679 150.7354
 700.00 5.41149 135.9994
 725.00 4.19222 121.5877
 750.00 2.78945 107.3620
 775.00 1.18947 93.4495
 800.00 -0.65876 79.9252
 825.00 -2.83560 66.9439

850.00	16.93253	145.3046
875.00	16.01123	147.0837
900.00	15.51180	149.0718
925.00	15.38691	149.8441
950.00	15.48910	148.5864
975.00	15.66892	145.1890
1000.00	15.82633	139.9269
1025.00	15.90991	133.1655
1050.00	15.90829	125.1824
1075.00	15.80011	116.3409
1100.00	15.60522	106.7966
1125.00	15.33576	96.7105
1150.00	15.00594	86.2252
1175.00	14.63044	75.4762
1200.00	14.22325	64.6118
1225.00	13.79670	53.7772
1250.00	13.36078	43.1339
1275.00	12.92306	32.8455
1300.00	12.48924	23.0716
1325.00	12.06435	13.9591
1350.00	11.65449	5.6319
1375.00	11.26843	358.1804
1400.00	10.91862	351.6499
1425.00	10.62090	346.0259
1450.00	10.39218	341.2251
1475.00	10.24653	337.0942
1500.00	10.19055	333.4260
1525.00	10.22027	329.9932
1550.00	10.32110	326.5874
1575.00	10.47087	323.0513
1600.00	10.64434	319.2908
1625.00	10.81732	315.2708
1650.00	10.96918	311.0012
1675.00	11.08393	306.5217
1700.00	11.15006	301.8862
1725.00	11.16008	297.1558
1750.00	11.10973	292.3918
1775.00	10.99737	287.6531
1800.00	10.82350	282.9444
1825.00	10.59039	278.4046
1850.00	10.30181	274.1064
1875.00	9.96290	269.9548
1900.00	9.57992	266.0356
1925.00	9.16002	262.3633
1950.00	8.71035	258.9380
1975.00	8.24001	255.7459
2000.00	7.75435	252.7557
2025.00	7.25911	249.9214
2050.00	6.75721	247.1845
2075.00	6.24862	244.4790
2100.00	5.73009	241.7368
2125.00	5.19532	238.8940
2150.00	4.63527	235.8947
2175.00	4.03888	232.6930
2200.00	3.39348	229.2525
2225.00	2.68531	225.5430
2250.00	1.89953	221.5351
2275.00	1.02007	217.1927
2300.00	0.02909	212.4614
2325.00	-1.09387	207.2525
2350.00	-2.37285	201.4150

850.00	1.55823	273.4644
875.00	-0.92556	243.5523
900.00	-2.78862	206.0069
925.00	-2.98147	165.6085
950.00	-1.88040	131.2336
975.00	-0.50272	104.3537
1000.00	0.67603	82.4164
1025.00	1.56587	63.3818
1050.00	2.14787	45.1867
1075.00	2.52508	29.7507
1100.00	2.69951	14.4776
1125.00	2.69403	359.7627
1150.00	2.52401	345.4807
1175.00	2.20148	331.5535
1200.00	1.72992	317.9348
1225.00	1.11072	304.6018
1250.00	0.34014	291.5515
1275.00	-0.59066	278.8025
1300.00	-1.09678	266.4001
1325.00	-3.00184	254.4306
1350.00	-4.54172	243.0504
1375.00	-6.57100	232.5677
1400.00	-8.57248	223.4955
1425.00	-11.20961	217.1488
1450.00	-14.57807	216.5953
1475.00	-18.08344	229.1416
1500.00	-19.08339	230.8428
1525.00	-16.81729	274.0483
1550.00	-14.34780	270.9989
1575.00	-12.48160	271.1980
1600.00	-11.13879	263.2432
1625.00	-10.18744	253.7978
1650.00	-9.53353	243.5677
1675.00	-9.11454	232.9162
1700.00	-8.88854	222.0544
1725.00	-8.82681	211.1205
1750.00	-8.90938	200.2160
1775.00	-9.12225	189.4255
1800.00	-9.45557	178.8276
1825.00	-9.90237	168.5037
1850.00	-10.45750	158.5437
1875.00	-11.11654	149.0533
1900.00	-11.87437	140.1606
1925.00	-12.72306	132.0231
1950.00	-13.64854	124.8304
1975.00	-14.62548	118.7993
2000.00	-15.61059	114.1436
2025.00	-16.53687	110.9991
2050.00	-17.31618	109.2937
2075.00	-17.86099	108.0189
2100.00	-18.12376	108.2468
2125.00	-18.12409	107.3798
2150.00	-17.93935	105.4592
2175.00	-17.65921	102.2831
2200.00	-17.36082	97.9191
2225.00	-17.09607	92.5624
2250.00	-16.89549	86.4370
2275.00	-16.77505	79.7494
2300.00	-16.74182	72.6749
2325.00	-16.79761	65.3586
2350.00	-16.94130	57.9212

850.00	-5.41980	54.9953
875.00	-8.70640	44.5380
900.00	-13.40352	38.6397
925.00	-20.44501	52.9764
950.00	-21.06740	120.0637
975.00	-15.38521	134.2345
1000.00	-12.10774	128.5356
1025.00	-10.12217	118.4413
1050.00	-8.84773	106.8211
1075.00	-8.06194	94.4345
1100.00	-7.61717	81.6596
1125.00	-7.43875	68.6442
1150.00	-7.48195	55.4601
1175.00	-7.71972	42.1405
1200.00	-8.13667	28.6946
1225.00	-8.72607	15.1133
1250.00	-9.48858	1.3680
1275.00	-10.43219	347.4060
1300.00	-11.57321	333.1370
1325.00	-12.93859	318.4077
1350.00	-14.56965	302.9470
1375.00	-16.52730	286.2471
1400.00	-18.89290	267.2744
1425.00	-21.72650	243.7563
1450.00	-24.75992	210.9310
1475.00	-26.39537	165.5042
1500.00	-25.18336	122.1428
1525.00	-23.00887	91.8895
1550.00	-21.14726	70.0159
1575.00	-19.74744	52.2964
1600.00	-18.73433	36.7877
1625.00	-18.02769	22.5991
1650.00	-17.56832	9.2901
1675.00	-17.31342	350.6284
1700.00	-17.23424	344.4880
1725.00	-17.30902	332.8030
1750.00	-17.52184	321.5447
1775.00	-17.86020	310.7107
1800.00	-18.31363	300.3203
1825.00	-18.87234	290.4104
1850.00	-19.52583	281.0359
1875.00	-20.26129	272.2661
1900.00	-21.06172	264.1812
1925.00	-21.90376	256.8604
1950.00	-22.75577	250.3632
1975.00	-23.57738	244.6937
2000.00	-24.32249	239.7608
2025.00	-24.94719	235.3461
2050.00	-25.42149	231.1133
2075.00	-25.73880	226.6726
2100.00	-25.91696	221.6782
2125.00	-25.98973	215.9018
2150.00	-25.99504	209.2526
2175.00	-25.96616	201.7515
2200.00	-25.92789	193.4902
2225.00	-25.89676	184.5963
2250.00	-25.88260	175.2102
2275.00	-25.89204	165.4724
2300.00	-25.92776	155.5177
2325.00	-25.99246	145.4720
2350.00	-26.08832	135.4512

2375.00	-3.83600	194.6868
2400.00	-5.51333	186.6044
2425.00	-7.42341	176.3318
2450.00	-9.52037	162.3968
2475.00	-11.52898	142.6940
2500.00	-12.70789	116.6863
2525.00	-12.37452	89.6875
2550.00	-10.99698	69.0060
2575.00	-9.39437	54.5491
2600.00	-7.92583	44.4035
2625.00	-6.66339	36.8870
2650.00	-5.59209	31.0016
2675.00	-4.68050	26.1693
2700.00	-3.89946	22.0416
2725.00	-3.22576	18.3968
2750.00	-2.64195	15.0877
2775.00	-2.13524	12.0136
2800.00	-1.69639	9.1048
2825.00	-1.31877	6.3136
2850.00	-0.99755	3.6083
2875.00	-0.72918	0.9694
2900.00	-0.51086	358.3860
2925.00	-0.34027	355.8547
2950.00	-0.21536	353.3762
2975.00	-0.13414	350.9541
3000.00	-0.09465	348.5945
3025.00	-0.09491	346.3037
3050.00	-0.13292	344.0884
3075.00	-0.20667	341.9546
3100.00	-0.31424	339.9067
3125.00	-0.45381	337.9482
3150.00	-0.62375	336.0818
3175.00	-0.82271	334.3079
3200.00	-1.04966	332.6270
3225.00	-1.30395	331.0386
3250.00	-1.58538	329.5432
3275.00	-1.85414	328.1414
3300.00	-2.23088	326.8364
3325.00	-2.59663	325.6335
3350.00	-2.99276	324.5417
3375.00	-3.42090	323.5740
3400.00	-3.88285	322.7483
3425.00	-4.38046	322.0884
3450.00	-4.91546	321.6252
3475.00	-5.48934	321.3972
3500.00	-6.10300	321.4524
3525.00	-6.75645	321.8491
3550.00	-7.44819	322.6577
3575.00	-8.17444	323.9624
3600.00	-8.92789	325.8591
3625.00	-9.69609	328.4539
3650.00	-10.45939	331.8521
3675.00	-11.18908	336.1372
3700.00	-11.84680	341.3372
3725.00	-12.38752	347.3792
3750.00	-12.76797	354.0532
3775.00	-12.95916	1.0189
3800.00	-12.95714	7.8709
3825.00	-12.78436	14.2438
3850.00	-12.48071	19.8909
3875.00	-12.09069	24.7048

2375.00	-17.16942	33.4653
2400.00	-17.47925	43.0806
2425.00	-17.86380	55.8484
2450.00	-18.31671	68.6436
2475.00	-18.82938	82.1364
2500.00	-19.39087	95.7900
2525.00	-19.98759	9.8576
2550.00	-20.60284	4.3151
2575.00	-21.21716	359.3513
2600.00	-21.80939	354.7581
2625.00	-22.35878	350.3208
2650.00	-22.84813	346.3183
2675.00	-23.26692	342.5945
2700.00	-23.61331	338.5801
2725.00	-23.89410	334.3203
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2850.00	-24.83501	306.7524
2875.00	-25.02666	300.0105
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GAMMA(DEG) = 90.0 PHI(DEG) = 90.0 ZT(KM) = 5.000 ZR(KM) = 10.000

Z
 RHO(KM) AMP(DB) ANG(DEG)
 25.00 27.51953 179.5762
 50.00 23.71263 152.9835
 75.00 21.24971 125.9061
 100.00 19.39833 98.5973
 125.00 17.93675 71.1025
 150.00 16.77313 43.4766
 175.00 15.86622 15.7935
 200.00 15.19932 348.1660
 225.00 14.68836 320.7561
 250.00 14.48950 293.9148
 275.00 14.50465 267.8486
 300.00 14.70259 242.8386

X
 RHO(KM) AMP(DB) ANG(DEG)
 25.00 26.64453 62.8635
 50.00 22.91521 38.9513
 75.00 20.57001 14.5238
 100.00 18.79927 350.0767
 125.00 17.37453 325.6606
 150.00 16.19505 301.3340
 175.00 15.20720 277.1655
 200.00 14.37761 253.2331
 225.00 13.53481 229.8249
 250.00 12.95894 206.7146
 275.00 12.47722 184.0815
 300.00 12.07032 161.9906

Y
 RHO(KM) AMP(DB) ANG(DEG)
 25.00 63.68800 244.1672
 50.00 60.18823 234.2179
 75.00 57.91200 224.2904
 100.00 56.08687 214.3877
 125.00 54.47812 204.4572
 150.00 52.97903 194.4384
 175.00 51.53078 184.2587
 200.00 50.09673 173.8283
 225.00 48.61855 163.2431
 250.00 47.15327 151.9935
 275.00 45.65547 140.0463
 300.00 44.12877 127.1591

325.00	15.04035	219.0932
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400.00	16.39468	155.8847
425.00	16.85536	137.5548
450.00	17.27397	120.3515
475.00	17.64844	103.9474
500.00	17.93361	88.7210
525.00	18.14555	74.3519
550.00	18.27980	60.7765
575.00	18.33372	47.9472
600.00	18.32005	35.7356
625.00	18.20772	24.3050
650.00	18.01485	13.5638
675.00	17.74373	3.5181
700.00	17.39825	354.1858
725.00	16.99300	345.5603
750.00	16.51900	337.7314
775.00	15.99590	330.7112
800.00	15.43928	324.5293
825.00	14.86887	319.1953
850.00	14.31038	314.6685
875.00	13.78281	310.6906
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1050.00	11.56709	291.1785
1075.00	11.29702	287.6381
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1150.00	10.11718	277.3931
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1350.00	4.34077	271.2544
1375.00	3.84725	274.4490
1400.00	3.54630	277.7913
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1450.00	3.41034	282.9800
1475.00	3.45772	284.3213
1500.00	3.50321	284.8274
1525.00	3.50453	284.6519
1550.00	3.43423	283.9922
1575.00	3.27662	283.6547
1600.00	3.02454	282.0403
1625.00	2.67735	281.1421
1650.00	2.24008	280.5479
1675.00	1.72384	280.4426
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1775.00	-0.61325	288.0117
1800.00	-1.05448	292.1438
1825.00	-1.34563	296.8435

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400.00	10.69120	79.5525
425.00	10.38532	60.6026
450.00	10.03420	42.2093
475.00	9.65236	23.8539
500.00	9.23174	6.5422
525.00	8.75738	349.6807
550.00	8.22102	333.2390
575.00	7.61479	317.1899
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625.00	6.17437	285.9973
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675.00	4.34158	256.3447
700.00	3.25451	242.0246
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850.00	-7.77410	167.8870
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1600.00	-22.64091	156.8653
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GAMMA(DEG)= 45.0 PHI(DEG)= 45.0 ZT(KM)= 5.000 ZR(KM)= 10.000

RHO(KM)	AMP(08)	ANG(08)
25.00	73.36125	265.0391
50.00	70.08977	259.2070
75.00	67.92786	253.8484
100.00	66.15047	249.0989
125.00	64.54466	245.1070
150.00	63.03299	242.0190
175.00	61.59627	239.9552
200.00	60.24879	238.9660
225.00	59.02640	238.9763
250.00	57.95911	239.7065
275.00	57.06750	240.7672
300.00	56.33910	241.6918
325.00	55.73026	242.0953
350.00	55.18227	241.7367
375.00	54.62460	240.6379
400.00	54.01028	238.8656
425.00	53.29570	236.5711
450.00	52.44432	233.9409
475.00	51.42180	231.1504
500.00	50.19116	228.5324
525.00	48.71306	226.3670
550.00	46.93167	225.1315
575.00	44.77299	225.6509
600.00	42.15192	229.5369
625.00	39.12422	240.4841
650.00	36.56781	263.8447
675.00	36.55359	293.9934
700.00	38.49928	313.6938
725.00	40.48842	323.0266
750.00	42.06168	327.1875
775.00	43.23714	328.9873
800.00	44.11003	329.7283
825.00	44.76305	330.0427
850.00	45.25908	330.2913
875.00	45.65749	330.5378
900.00	45.99010	330.8499
925.00	46.28499	331.2070
950.00	46.56055	331.5488
975.00	46.82620	331.7981
1000.00	47.08368	331.8826
1025.00	47.32916	331.7485
1050.00	47.55850	331.3896
1075.00	47.75908	330.7561
1100.00	47.92465	329.8936
1125.00	48.04921	328.8403
1150.00	48.12877	327.6431
1175.00	48.16132	326.3525
1200.00	48.14668	325.0198
1225.00	48.08629	323.6917
1250.00	47.98289	322.4111
1275.00	47.84032	321.2139
1300.00	47.66312	320.1277

RHO(KM)	AMP(08)	ANG(08)
25.00	57.11514	156.6898
50.00	53.49205	140.1229
75.00	51.01920	123.7443
100.00	48.91153	107.5658
125.00	46.91699	91.5318
150.00	44.90222	75.5724
175.00	42.76662	59.5856
200.00	40.40565	43.3987
225.00	37.67102	27.3144
250.00	34.37202	9.4327
275.00	30.01935	347.9233
300.00	23.72365	312.0378
325.00	20.49284	226.4470
350.00	25.65434	172.5098
375.00	29.25513	149.1073
400.00	31.41409	131.6532
425.00	32.78314	116.3058
450.00	33.65111	101.9943
475.00	34.15388	87.8769
500.00	34.37671	74.7264
525.00	34.37863	61.9221
550.00	34.18842	49.4188
575.00	33.82356	37.1980
600.00	33.32080	25.1744
625.00	32.62607	13.4951
650.00	31.76903	2.1542
675.00	30.74326	351.2156
700.00	29.53743	340.7849
725.00	28.19783	331.3821
750.00	26.60345	322.4446
775.00	24.76787	314.8547
800.00	22.67577	309.3911
825.00	20.36671	307.3909
850.00	18.30606	311.5066
875.00	16.71956	319.9011
900.00	16.33151	330.1516
925.00	16.95714	336.4089
950.00	17.91704	336.9797
975.00	18.80157	333.2344
1000.00	19.48572	326.7056
1025.00	19.95906	318.4048
1050.00	20.30281	308.8118
1075.00	20.41367	298.4812
1100.00	20.39037	287.6433
1125.00	20.25542	276.4707
1150.00	20.02751	265.1055
1175.00	19.72183	253.6769
1200.00	19.35040	242.3113
1225.00	18.92242	231.1390
1250.00	18.44467	220.2960
1275.00	17.92241	209.9243
1300.00	17.36058	200.1723

RHO(KM)	AMP(08)	ANG(08)
25.00	58.60384	244.4052
50.00	55.07178	232.9102
75.00	52.70839	221.4883
100.00	50.75159	210.2073
125.00	48.96678	199.0488
150.00	47.24698	187.9899
175.00	45.53255	176.9999
200.00	43.78535	166.0356
225.00	41.96317	155.2063
250.00	40.07841	144.0976
275.00	38.09776	132.7166
300.00	36.01187	120.8413
325.00	33.82320	108.1289
350.00	31.51431	94.4895
375.00	29.25627	78.5070
400.00	27.18816	59.9062
425.00	25.60826	38.8601
450.00	24.78053	17.1417
475.00	24.54012	357.2512
500.00	24.92218	340.8103
525.00	25.50070	327.4890
550.00	26.12001	316.4548
575.00	26.70790	306.9026
600.00	27.13791	298.1245
625.00	27.59230	290.0906
650.00	27.95822	282.2388
675.00	28.22745	274.4153
700.00	28.39357	266.5317
725.00	28.39462	258.5354
750.00	28.34650	250.5148
775.00	28.18394	242.3339
800.00	27.90222	233.9868
825.00	27.49591	225.4664
850.00	26.91833	216.7983
875.00	26.24445	207.9541
900.00	25.42175	198.8510
925.00	24.43529	189.4142
950.00	23.26511	179.5198
975.00	21.88472	168.9588
1000.00	20.26039	157.3678
1025.00	18.35500	144.0893
1050.00	16.12134	128.1226
1075.00	13.72663	106.9029
1100.00	11.69327	78.0407
1125.00	11.11564	43.9152
1150.00	12.13743	14.0309
1175.00	13.68418	352.2346
1200.00	15.10115	336.2466
1225.00	16.23962	323.7063
1250.00	17.11160	313.2551
1275.00	17.75919	304.1621
1300.00	18.22292	296.0198

1325.00	47.45625	319.1721
1350.00	47.22479	318.3572
1375.00	46.97346	317.6855
1400.00	46.70638	317.1514
1425.00	46.42665	316.7437
1450.00	46.13620	316.4482
1475.00	45.83569	316.2507
1500.00	45.52463	316.1396
1525.00	45.20154	316.1086
1550.00	44.86438	316.1592
1575.00	44.51093	316.3010
1600.00	44.13921	316.5522
1625.00	43.74802	316.9397
1650.00	43.33723	317.4908
1675.00	42.90826	318.2620
1700.00	42.46429	319.2747
1725.00	42.01051	320.5740
1750.00	41.55423	322.1924
1775.00	41.10404	324.1519
1800.00	40.67255	326.4590
1825.00	40.26942	329.0994
1850.00	39.90643	332.0366
1875.00	39.59306	335.2119
1900.00	39.33594	338.5498
1925.00	39.13805	341.9600
1950.00	38.99855	345.3787
1975.00	38.91338	348.7129
2000.00	38.87622	351.9104
2025.00	38.87961	354.9307
2050.00	38.91591	357.7480
2075.00	38.97797	0.3502
2100.00	39.05943	2.7330
2125.00	39.15480	4.6985
2150.00	39.25931	6.8519
2175.00	39.36880	8.6007
2200.00	39.47960	10.1535
2225.00	39.58835	11.5203
2250.00	39.69272	12.7124
2275.00	39.78787	13.7426
2300.00	39.87349	14.6251
2325.00	39.94684	15.3752
2350.00	40.00620	16.0091
2375.00	40.05031	16.5436
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2425.00	40.08961	17.3816
2450.00	40.08411	17.7173
2475.00	40.06192	18.0172
2500.00	40.02339	18.2948
2525.00	39.96910	18.5619
2550.00	39.89967	18.8290
2575.00	39.81590	19.1052
2600.00	39.71852	19.3984
2625.00	39.60829	19.7153
2650.00	39.48595	20.0621
2675.00	39.35217	20.4443
2700.00	39.20763	20.8673
2725.00	39.05293	21.3362
2750.00	38.88876	21.8564
2775.00	38.71577	22.4335
2800.00	38.53474	23.0730
2825.00	38.34654	23.7807

1325.00	16.76563	191.1921
1350.00	16.14803	183.1353
1375.00	15.52505	176.1412
1400.00	14.92334	170.3143
1425.00	14.37974	165.6858
1450.00	13.93764	162.1656
1475.00	13.63709	159.5098
1500.00	13.50081	157.3369
1525.00	13.52376	155.2159
1550.00	13.67415	152.7605
1575.00	13.90500	149.8052
1600.00	14.16795	146.2126
1625.00	14.42235	142.0338
1650.00	14.63827	137.3597
1675.00	14.79572	132.3040
1700.00	14.88251	126.9820
1725.00	14.89204	121.5011
1750.00	14.82165	115.9578
1775.00	14.67146	110.4375
1800.00	14.44368	105.0167
1825.00	14.14230	99.7631
1850.00	13.77298	94.7368
1875.00	13.34304	89.9694
1900.00	12.86156	85.5619
1925.00	12.33929	81.4611
1950.00	11.76838	77.7548
1975.00	11.22169	74.3668
2000.00	10.65162	71.2727
2025.00	10.08859	68.3990
2050.00	9.53934	65.6472
2075.00	9.00558	62.9026
2100.00	8.48346	60.3472
2125.00	7.96401	56.9721
2150.00	7.43434	53.5655
2175.00	6.87928	49.8163
2200.00	6.28295	45.6112
2225.00	5.62991	40.9267
2250.00	4.90599	35.7198
2275.00	4.09888	29.9356
2300.00	3.19884	23.4933
2325.00	2.20012	16.2705
2350.00	1.10400	8.0845
2375.00	-0.07509	338.6770
2400.00	-1.29818	347.7180
2425.00	-2.43475	334.8770
2450.00	-3.49926	320.0366
2475.00	-4.17250	303.6572
2500.00	-4.38646	286.9529
2525.00	-4.16261	271.4023
2550.00	-3.63940	257.9551
2575.00	-2.97130	246.7942
2600.00	-2.26623	237.6445
2625.00	-1.58173	230.1005
2650.00	-0.94242	223.7839
2675.00	-0.35578	218.3870
2700.00	0.17818	213.6708
2725.00	0.66191	209.4521
2750.00	1.09797	205.5923
2775.00	1.48821	201.9876
2800.00	1.83358	198.5625
2825.00	2.13435	195.2640

1325.00	18.53625	288.5864
1350.00	18.72600	281.7083
1375.00	18.81354	275.2795
1400.00	18.81606	269.2212
1425.00	18.74724	263.4680
1450.00	18.61778	257.9639
1475.00	18.43576	252.6578
1500.00	18.20676	247.5033
1525.00	17.93413	242.4584
1550.00	17.61919	237.4872
1575.00	17.26147	232.5607
1600.00	16.85910	227.6581
1625.00	16.40894	222.7678
1650.00	15.90699	217.8882
1675.00	15.34865	213.0284
1700.00	14.72885	208.2083
1725.00	14.04234	203.4602
1750.00	13.28375	198.8300
1775.00	12.44789	194.3798
1800.00	11.53037	190.1917
1825.00	10.52675	186.3739
1850.00	9.43676	183.0672
1875.00	8.26364	180.4544
1900.00	7.01978	178.7662
1925.00	5.73334	178.2740
1950.00	4.45803	179.2513
1975.00	3.28140	181.8535
2000.00	2.31833	185.9251
2025.00	1.67370	190.8284
2050.00	1.38150	195.5597
2075.00	1.36344	199.1903
2100.00	1.56847	201.2352
2125.00	1.83005	201.6584
2150.00	2.09379	200.6715
2175.00	2.31725	198.5569
2200.00	2.48024	195.5798
2225.00	2.57576	191.9600
2250.00	2.60386	187.8720
2275.00	2.56811	183.4524
2300.00	2.47361	178.8083
2325.00	2.32583	174.0255
2350.00	2.13006	169.1732
2375.00	1.89154	164.3088
2400.00	1.61272	159.4811
2425.00	1.29816	154.7326
2450.00	0.94944	150.1020
2475.00	0.56760	145.6262
2500.00	0.15265	141.3424
2525.00	-0.29633	137.2909
2550.00	-0.76110	133.5177
2575.00	-1.30395	130.0782
2600.00	-1.86726	127.0410
2625.00	-2.47270	124.4928
2650.00	-3.12026	122.5435
2675.00	-3.80572	121.3307
2700.00	-4.51809	121.0200
2725.00	-5.23481	121.7950
2750.00	-5.91649	123.8241
2775.00	-6.57337	127.1898
2800.00	-6.92322	131.7800
2825.00	-7.09649	137.1981

2850.00	38.15218	24.5621	2850.00	2.39039	192.0573	2850.00	-6.99779	142.8016
2875.00	37.95282	25.4225	2875.00	2.60146	188.9219	2875.00	-6.64539	147.9101
2900.00	37.74976	26.3665	2900.00	2.76745	185.8479	2900.00	-6.10488	152.0447
2925.00	37.54451	27.3976	2925.00	2.88852	182.8337	2925.00	-5.45520	155.0186
2950.00	37.33868	28.5183	2950.00	2.96521	179.8829	2950.00	-4.76389	156.8727
2975.00	37.13399	29.7296	2975.00	2.99845	177.0025	2975.00	-4.07814	157.7642
3000.00	36.93224	31.0306	3000.00	2.98957	174.2013	3000.00	-3.42671	157.8821
3025.00	36.73520	32.4186	3025.00	2.94024	171.4884	3025.00	-2.82505	157.4049
3050.00	36.54466	33.8891	3050.00	2.85240	168.8723	3050.00	-2.28037	156.4846
3075.00	36.36223	35.4356	3075.00	2.72816	166.3596	3075.00	-1.79359	155.2452
3100.00	36.18941	37.0499	3100.00	2.56968	163.9552	3100.00	-1.36446	153.7652
3125.00	36.02744	38.7224	3125.00	2.37906	161.6613	3125.00	-0.98992	152.1827
3150.00	35.87733	40.4422	3150.00	2.15819	159.4778	3150.00	-0.66634	150.4990
3175.00	35.73982	42.1979	3175.00	1.90864	157.4022	3175.00	-0.38968	148.7824
3200.00	35.61536	43.9772	3200.00	1.63148	155.4304	3200.00	-0.15577	147.0705
3225.00	35.50404	45.7681	3225.00	1.32724	153.5572	3225.00	0.03959	145.3927
3250.00	35.40576	47.5585	3250.00	0.99580	151.7775	3250.00	0.20046	143.7710
3275.00	35.32010	49.3373	3275.00	0.63634	150.0870	3275.00	0.33075	142.2221
3300.00	35.24641	51.0939	3300.00	0.24737	148.4840	3300.00	0.43416	140.7577
3325.00	35.18388	52.8186	3325.00	-0.17327	146.9698	3325.00	0.51416	139.3854
3350.00	35.13145	54.5033	3350.00	-0.62834	145.5504	3350.00	0.57396	138.1095
3375.00	35.08800	56.1408	3375.00	-1.12113	144.2376	3375.00	0.61647	136.9317
3400.00	35.05225	57.7253	3400.00	-1.65538	143.0497	3400.00	0.64434	135.8510
3425.00	35.02290	59.2527	3425.00	-2.23527	142.0134	3425.00	0.65992	134.8649
3450.00	34.99858	60.7198	3450.00	-2.86495	141.1051	3450.00	0.66528	133.9694
3475.00	34.97798	62.1251	3475.00	-3.54913	140.3532	3475.00	0.66223	133.1592
3500.00	34.95975	63.4683	3500.00	-4.29221	140.2409	3500.00	0.65229	132.4285
3525.00	34.94263	64.7501	3525.00	-5.09827	140.3108	3525.00	0.63675	131.7705
3550.00	34.92546	65.9724	3550.00	-5.97038	140.6707	3550.00	0.61666	131.1785
3575.00	34.90717	67.1379	3575.00	-6.90940	142.0618	3575.00	0.59283	130.6451
3600.00	34.88876	68.2501	3600.00	-7.91166	144.3673	3600.00	0.56586	130.1632
3625.00	34.86340	69.3131	3625.00	-8.96473	147.1208	3625.00	0.53613	129.7257
3650.00	34.83633	70.3313	3650.00	-10.04030	151.5008	3650.00	0.50381	129.3257
3675.00	34.80498	71.3096	3675.00	-11.08376	157.4908	3675.00	0.46889	128.9570
3700.00	34.76881	72.2530	3700.00	-12.09668	165.2618	3700.00	0.43115	128.6138
3725.00	34.72746	73.1664	3725.00	-12.68218	174.6602	3725.00	0.39024	128.2913
3750.00	34.68063	74.0551	3750.00	-13.05503	185.0171	3750.00	0.34564	127.9859
3775.00	34.62814	74.9240	3775.00	-12.93582	195.2635	3775.00	0.29676	127.6951
3800.00	34.56987	75.7779	3800.00	-12.53720	204.4069	3800.00	0.24291	127.4177
3825.00	34.50578	76.6215	3825.00	-11.92775	211.9312	3825.00	0.18341	127.1539
3850.00	34.43591	77.4594	3850.00	-11.22000	217.7954	3850.00	0.11760	126.9056
3875.00	34.36034	78.2958	3875.00	-10.49221	222.2127	3875.00	0.04469	126.6757
3900.00	34.27922	79.1350	3900.00	-9.78909	225.4627	3900.00	-0.03519	126.4684
3925.00	34.19275	79.9807	3925.00	-9.13274	227.8018	3925.00	-0.12296	126.2892
3950.00	34.10117	80.8368	3950.00	-8.53218	229.4371	3950.00	-0.21853	126.1440
3975.00	34.00476	81.7067	3975.00	-7.98961	230.3280	3975.00	-0.32182	126.0394
4000.00	33.90387	82.5936	4000.00	-7.50390	231.1949	4000.00	-0.43251	125.9823
4025.00	33.79887	83.5005	4025.00	-7.07246	231.5293	4025.00	-0.55006	125.9793
4050.00	33.69019	84.4301	4050.00	-6.69224	231.6012	4050.00	-0.67367	126.0365
4075.00	33.57828	85.3849	4075.00	-6.36012	231.4651	4075.00	-0.80235	126.1545
4100.00	33.46359	86.3668	4100.00	-6.07313	231.1647	4100.00	-0.93490	126.3525
4125.00	33.34668	87.3770	4125.00	-5.82856	230.7349	4125.00	-1.07030	126.6184
4150.00	33.22810	88.4186	4150.00	-5.62390	230.2050	4150.00	-1.20618	126.9586
4175.00	33.10840	89.4907	4175.00	-5.45687	229.5993	4175.00	-1.34194	127.3727
4200.00	32.98814	90.5943	4200.00	-5.32539	228.9385	4200.00	-1.47576	127.8584
4225.00	32.86792	91.7293	4225.00	-5.22752	228.2405	4225.00	-1.60620	128.4117
4250.00	32.74829	92.8953	4250.00	-5.16151	227.5207	4250.00	-1.73192	129.0267
4275.00	32.62981	94.0914	4275.00	-5.12572	226.7927	4275.00	-1.85176	129.6962
4300.00	32.51302	95.3163	4300.00	-5.11864	226.0684	4300.00	-1.96479	130.4117
4325.00	32.39841	96.5679	4325.00	-5.13890	225.3583	4325.00	-2.07031	131.1637
4350.00	32.28642	97.8443	4350.00	-5.18526	224.6719	4350.00	-2.16791	131.9424

4375.00	32.17747	99.1429
4400.00	32.07191	100.4608
4425.00	31.97092	101.7950
4450.00	31.87202	103.1423
4475.00	31.77806	104.4992
4500.00	31.68823	105.8623
4525.00	31.60255	107.2283
4550.00	31.52095	108.5938
4575.00	31.44331	109.9555
4600.00	31.36946	111.3105
4625.00	31.29918	112.6559
4650.00	31.23216	113.9893
4675.00	31.16811	115.3086
4700.00	31.10664	116.6118
4725.00	31.04741	117.8975
4750.00	30.99092	119.1645
4775.00	30.93405	120.4122
4800.00	30.87914	121.6402
4825.00	30.82486	122.8483
4850.00	30.77087	124.0368
4875.00	30.71678	125.2063
4900.00	30.66229	126.3576
4925.00	30.60707	127.4917
4950.00	30.55086	128.6099
4975.00	30.49339	129.7134
5000.00	30.43448	130.8039

4375.00	-5.25658	224.0178
4400.00	-5.35184	223.4043
4425.00	-5.47915	222.8391
4450.00	-5.61070	222.3299
4475.00	-5.77276	221.8845
4500.00	-5.95564	221.5112
4525.00	-6.15870	221.2188
4550.00	-6.38128	221.0166
4575.00	-6.62266	220.9152
4600.00	-6.88200	220.9255
4625.00	-7.15834	221.0598
4650.00	-7.45047	221.3310
4675.00	-7.75691	221.7527
4700.00	-8.07582	222.3390
4725.00	-8.40497	223.1041
4750.00	-8.74161	224.0617
4775.00	-9.08249	225.2244
4800.00	-9.42377	226.6025
4825.00	-9.76103	228.2032
4850.00	-10.09935	230.0294
4875.00	-10.43330	232.0780
4900.00	-10.69747	234.3387
4925.00	-10.96615	236.7935
4950.00	-11.20425	239.4155
4975.00	-11.40738	242.1700
5000.00	-11.57233	245.0155

4375.00	-2.25746	132.7377
4400.00	-2.33907	133.5397
4425.00	-2.41311	134.3393
4450.00	-2.48018	135.1283
4475.00	-2.54101	135.8992
4500.00	-2.59651	136.6463
4525.00	-2.64765	137.3646
4550.00	-2.69544	138.0508
4575.00	-2.74091	138.7028
4600.00	-2.78508	139.3194
4625.00	-2.82891	139.9006
4650.00	-2.87328	140.4474
4675.00	-2.91901	140.9613
4700.00	-2.96681	141.4446
4725.00	-3.01730	141.8999
4750.00	-3.07099	142.3304
4775.00	-3.12830	142.7392
4800.00	-3.18956	143.1295
4825.00	-3.25500	143.5047
4850.00	-3.32479	143.8679
4875.00	-3.39903	144.2221
4900.00	-3.47774	144.5701
4925.00	-3.56092	144.9146
4950.00	-3.64855	145.2577
4975.00	-3.74054	145.6017
5000.00	-3.83684	145.9482

IV. Program Checks and Some Results

The sample input output case discussed in the previous section is an example of one of a number of checks made of the current program. That particular case represents propagation in a very slightly inhomogeneous guide in which the horizontal inhomogeneity begins just 25 km from the transmitter (i.e. $XVAL(8) = 25.0$ km since a nine slab model was used for the inhomogeneity) and is 1000 km in extent. The ionosphere is described by exponentials and in the convention of Wait and Spies⁷ varies linearly over its 1000 km extent from $H' = 70$ km to $H' = 71$ km with constant $\beta = 0.3 \text{ km}^{-1}$. This is a sufficiently modest inhomogeneity that one would expect the mode conversion and WKB results to be identical for all practical purposes. Figures 3 through 5 show the mode conversion and WKB results for the electric field components E_z , E_x and E_y for four orientations of the transmitter. The latter was at 5 km and the receiver at 10 km. Examination of the plots will show that the mode conversion and WKB results are indeed very nearly identical.

As an example of a more realistic terminator problem, Figures 6 through 8 show the E_z , E_x and E_y results for a Hawaii-San Diego path as a function of terminator location (i.e. the abscissa is the distance from the transmitter to $XVAL(20)$ since 21 slabs were used to model the terminator) for a transmitter and receiver altitude of 15 km. The terminator extends 1000 km and the ionosphere (again assumed exponential) varies from $H' = 86$ km, $\beta = 0.5 \text{ km}^{-1}$ to $H' = 70$ km, $\beta = 0.3 \text{ km}^{-1}$. Curves for four orientations of the transmitter are shown on each plot. Some jaggedness in some of the plots occurs as new slabs pass over the transmitter or receiver. However, the jaggedness would have been much worse for the E_y case except for the fact that the fundamental input from the waveguide runs (i.e. the program of reference 4) was generated using tolerances of 10^{-5} degrees for both real and imaginary parts of the eigenangle as compared

with our usual tolerances of 0.01^0 for the real part and 0.005^0 for the imaginary part. The increased tolerance results in only a slight increase in execution time of the waveguide program and we would recommend using the smaller tolerance when generating data for the present program and when E_y fields are of interest.

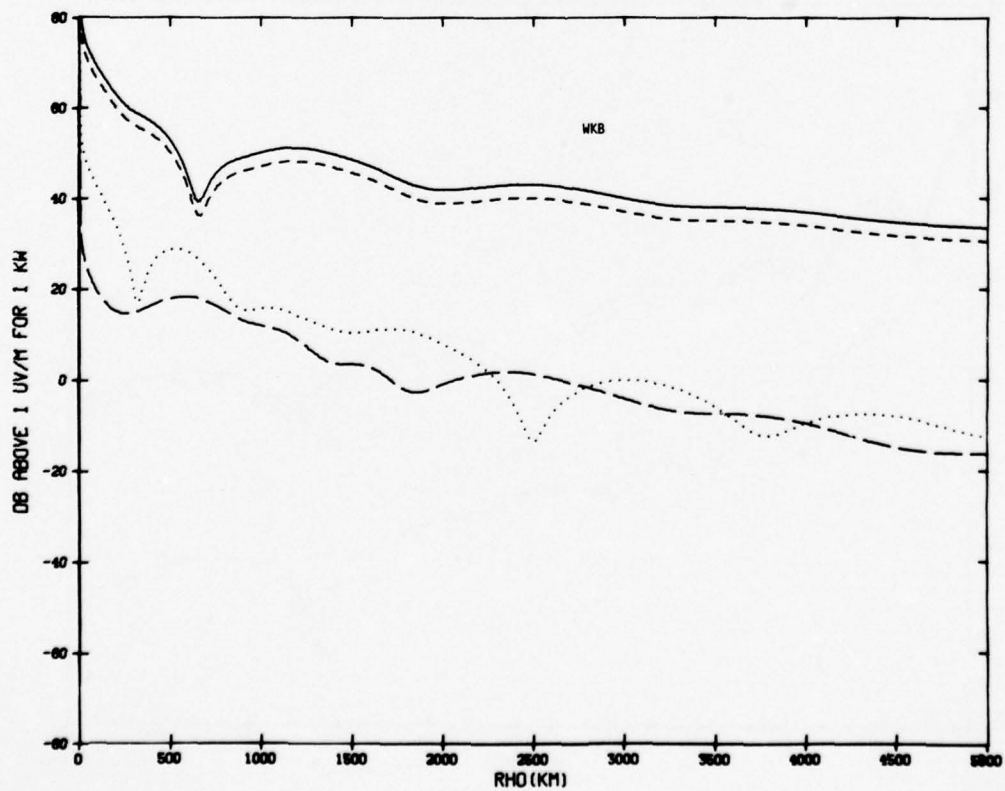
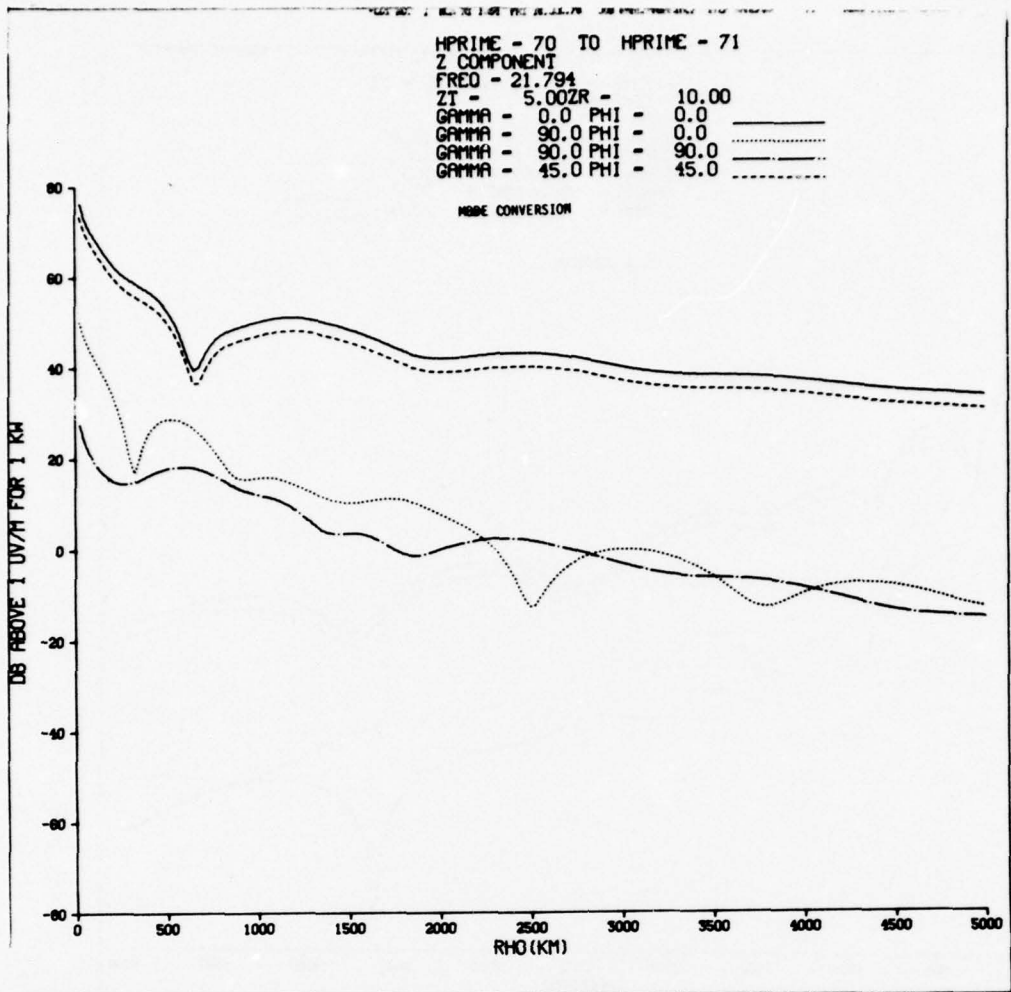


FIGURE 3

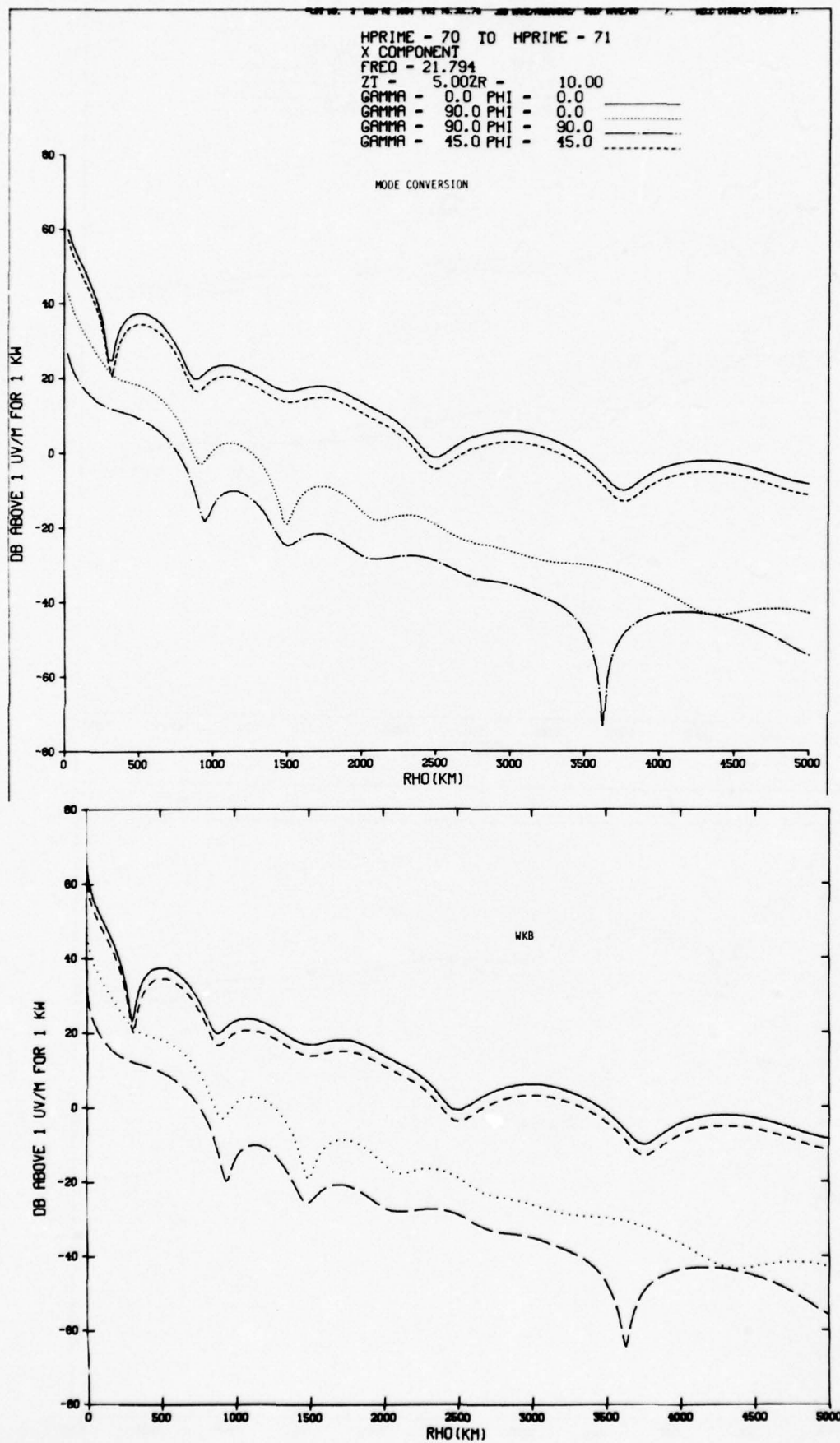


FIGURE 4

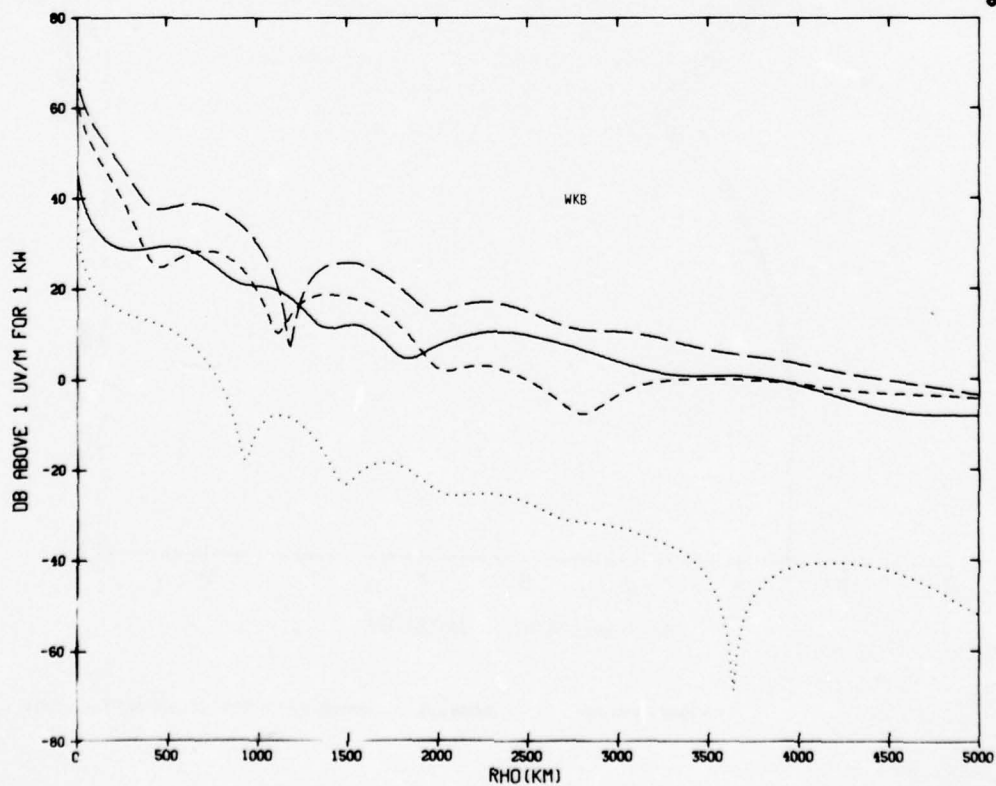
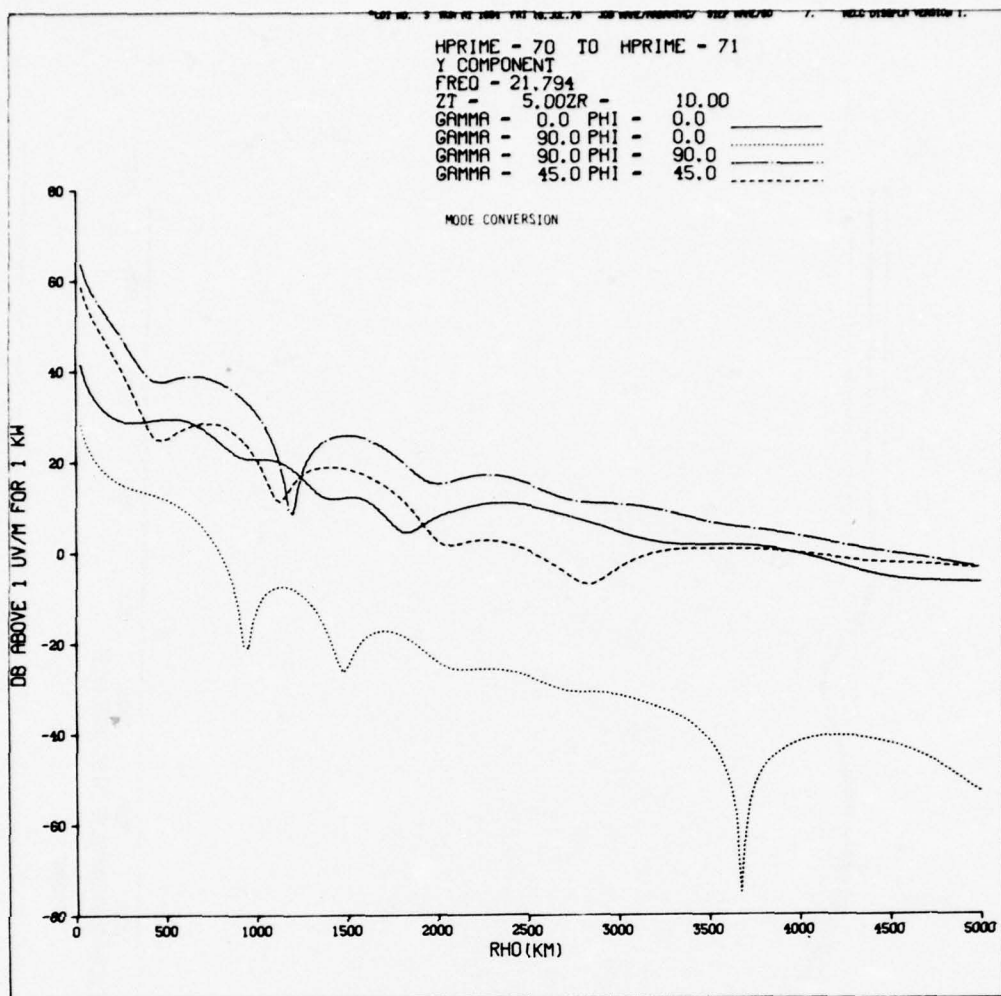


FIGURE 5

HPRIME-86(SLAB21) TO HPRIME-70(SLAB 1)

Z COMPONENT

FREQ - 21.794

ZI - 15.00ZR - 15.00

RECEIVER DISTANCE - 3821.0

GAMMA - 45.0 PHI - 0.0
 GAMMA - 45.0 PHI - 90.0
 GAMMA - 45.0 PHI - 180.0
 GAMMA - 45.0 PHI - 270.0

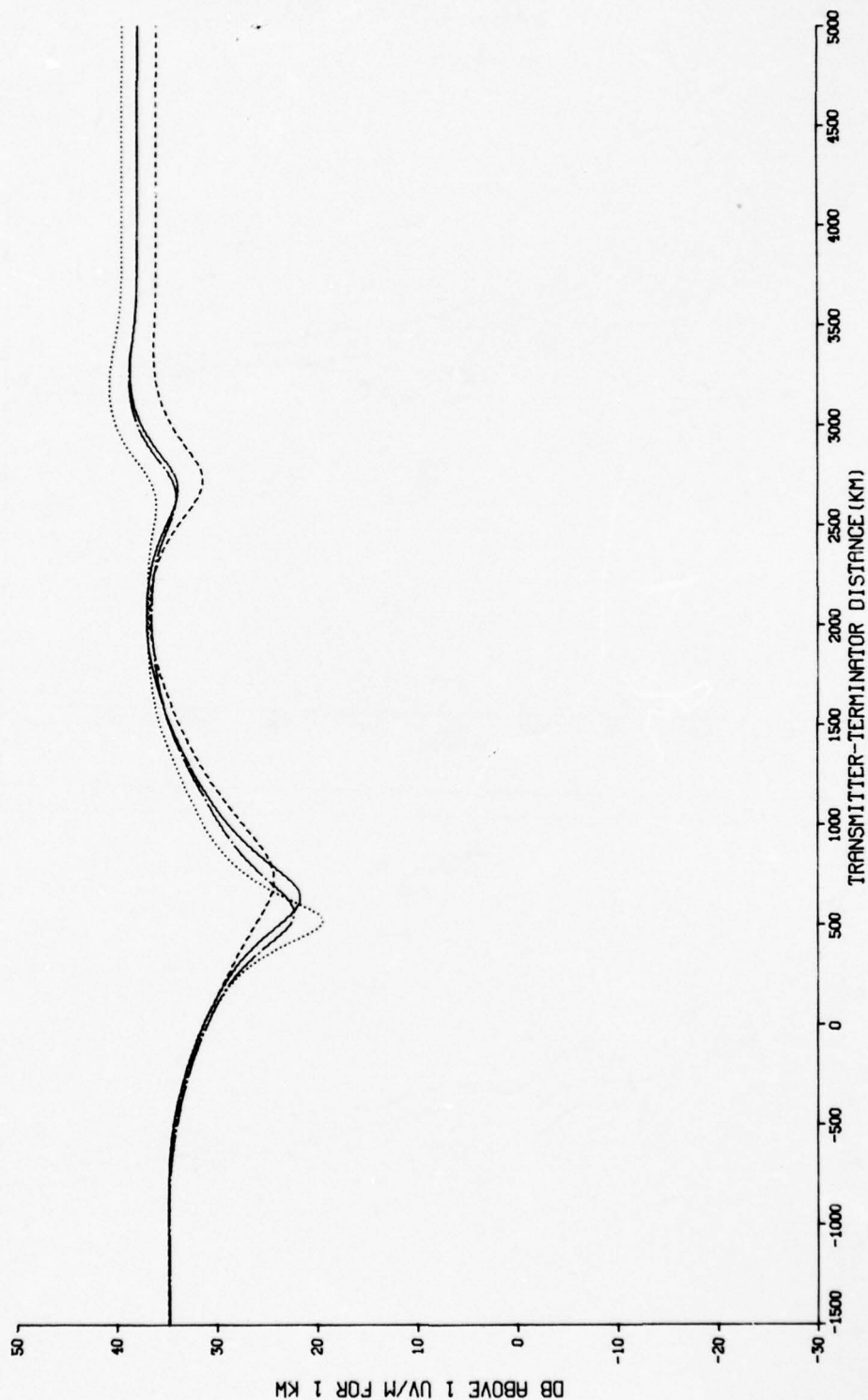


FIGURE 6

HPRIME-86(SLAB21) TO HPRIME-70(SLAB 1)
 X COMPONENT
 FREQ - 21.794
 ZI - 15.00ZR - 15.00
 RECEIVER DISTANCE - 3821.0

GAMMA - 45.0 PHI - 0.0
 GAMMA - 45.0 PHI - 90.0
 GAMMA - 45.0 PHI - 180.0
 GAMMA - 45.0 PHI - 270.0

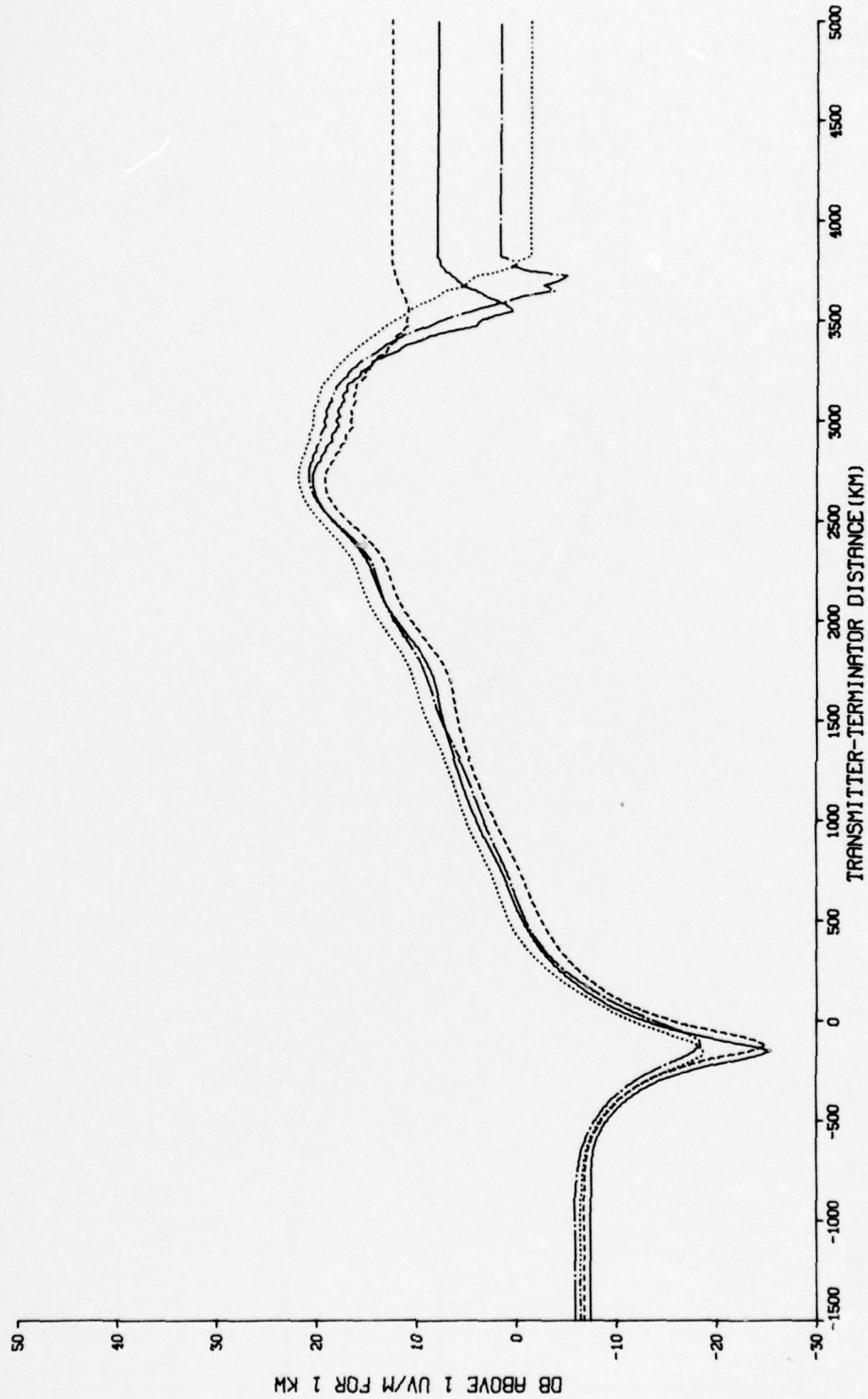


FIGURE 7

HPRIME-86(SLAB21) TO HPRIME-70(SLAB 1)

Y COMPONENT

FREQ - 21.794

ZT - 15.00ZR - 15.00

RECEIVER DISTANCE - 3821.0

GAMMA - 45.0 PHI - 0.0
 GAMMA - 45.0 PHI - 90.0
 GAMMA - 45.0 PHI - 180.0
 GAMMA - 45.0 PHI - 270.0

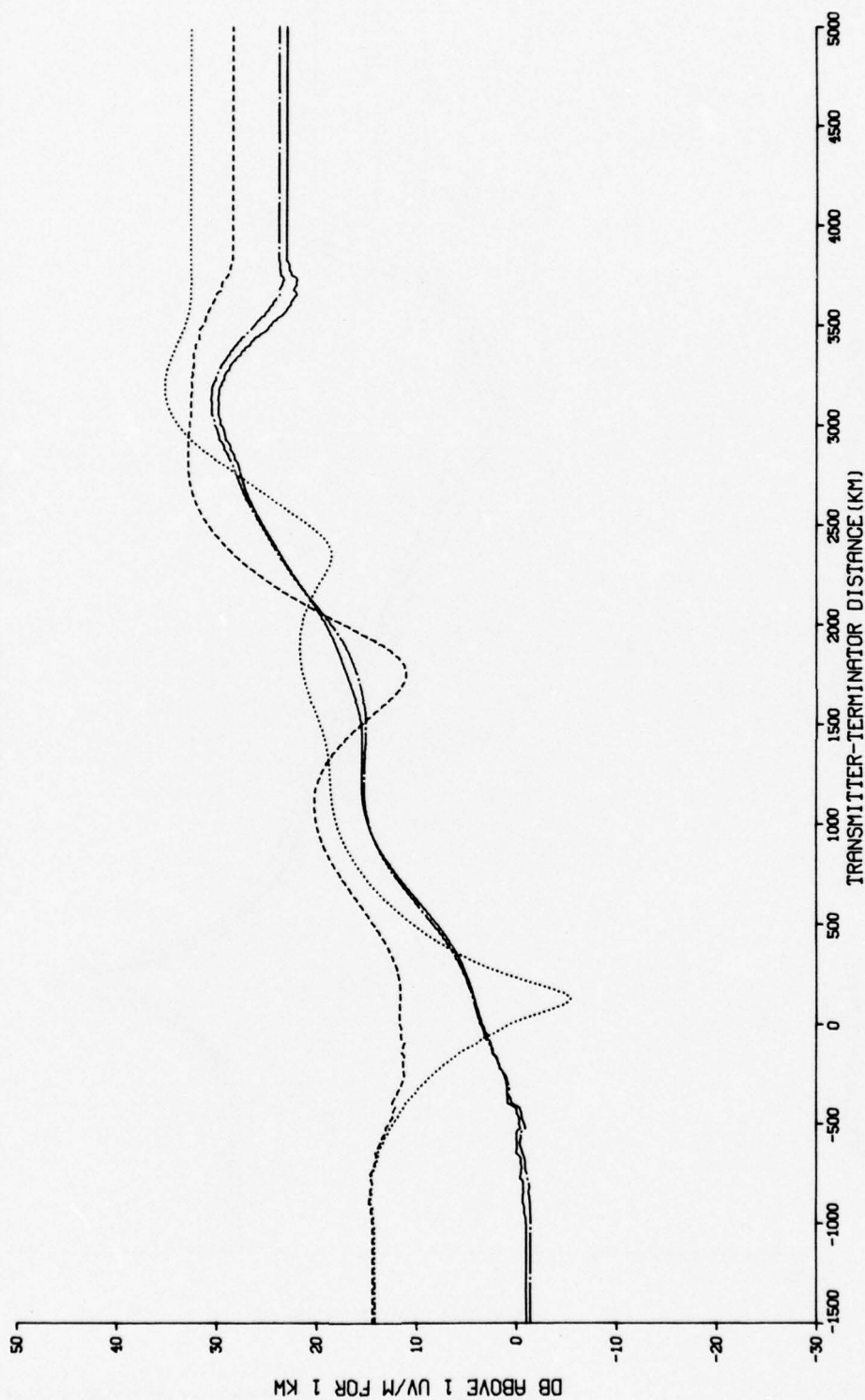


FIGURE 8

PLT NO. 5 RUN AT 1750 HED 14.44.78 JOB NAME/NUMBER/ STEP NAME/NO / WELD DISTANCE VERSION 1.

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APPENDIX:
LISTING OF PROGRAM

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C SIMPLIFIED MODE CONVERSION MODEL MODIFIED TO CALCULATE FIELDS
C FOR AN ANTENNA OF ARBITRARY HEIGHT AND ORIENTATION.
  IMPLICIT REAL *8(A-H,O-Z)
  COMMON/HGTEMP/FF1(25,5),FF3(25,5)
  COMMON/TERM/NT,NTR
  COMMON/CAP/CAPI(25,5,5),TNORM(25,5,5)
  COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(3,3,25,5),TOPHT(25),
$      XVAL(25),FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON(25),
$      SIGMA(25),NRSLAB,NRMODE,NTMAX
  COMMON/MCSTOR/A(25,5,5),S(25,5),C(25,5),NTHSQ(25),KVRAT,KVRATT,
$      AVRKOT,AVRKT,CONST,OMEGA,WAVENO
  COMMON/MCFLOR/R(400),DB(3,4,400),ANG(3,4,400),IDPLOT(10),ISUB,NRP
  COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
  COMMON/HGINPT/GAMMA(4),PHI(4),ZT,ZR
$ ,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)
  DIMENSION BUFFER(2000)
  DIMENSION Z(2)
  REAL*4 BCD(20),OUT/* GEN*/
  REAL*4 R,DB,ANG,XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
  COMPLEX*16 FF1,FF3
  COMPLEX*16 THETA,A,S,C,FOFR,IM/(0.0D0,1.0D0)/,CAPI,TNORM
  COMPLEX*16 XTKA,NTHSQ,T1,T2,T3,T4
  DATA TWOPI/6.283185D0/,VELITE/2.997928D5/,ALPHA/3.14D-4/,
$   DEGRAD/1.745329D-2/
  DATA LAST/0/,IPRNTA/0/
  REAL*8 KVRAT,KVRATT
  NAMELIST/DATUM/      RHOMAX,
$   RHOMIN,DELTAX,NRSLAB,NRMODE,NTMAX,XVAL,FREQ,IDPLOT,EPSLON,
$   SIGMA,DELRHO,IFIRST,LAST,IPLTOP,
$   XMIN,XINC,YMIN,YINC,SIZEX,SIZEY,
$   GAMMA,PHI,ZT,ZR,NRP,IPRNTA
$   ,INTFLG

C
  INTFLG=0
  IDPLOT(1) = 0
10  DO 250 K=1,200
    READ(5,201) BCD
    WRITE(6,202) BCD
    WRITE(1,201) BCD
    IF(BCD(1) .EQ. OUT) GO TO 260
250  CONTINUE
260  REWIND 1
    READ(1,DATUM)
    REWIND 1
    DO 200 N=1,NRP
      GAMMA(N) = GAMMA(N)*DEGRAD
      PHI(N) = PHI(N)*DEGRAD
      SINGAM(N) = DSIN(GAMMA(N))
      COSGAM(N) = DCOS(GAMMA(N))
      SINPHI(N) = DSIN(PHI(N))
      COSPHI(N) = DCOS(PHI(N))
200  CONTINUE
    PRINT 102

```

```

DO 110 M=1,NRSLAB
DO 110 K=1,NRMODE
READ 100, THETA(M,K),T1,T2
READ 100, THETA(M,K),T3,T4
READ 101, FOFF(M,K),TOPHT(M)
PRINT 103,THETA(M,K),T1,T2,T3,T4,FOFR(M,K),TOPHT(M)
102 FORMAT(5X,'THETA',15X,'T1',20X,'T2',20X,'T3',20X,'T4',20X,'FOFR',
5 10X,'TOPHT')
103 FORMAT(' ',2F7.3,2X,5(2D10.3,2X),F4.1)
100 FORMAT(1X,2F9.5,1X,4D15.6)
101 FORMAT(41X,2D10.6,2X,F5.2)
S(M,K) = CDSIN(THETA(M,K)*DEGRAD)
C(M,K) = CDCOS(THETA(M,K)*DEGRAD)
XTRA(1,1,M,K) = T1*S(M,K)**2
XTRA(1,2,M,K) = T1*S(M,K)
XTRA(1,3,M,K) = -T3*S(M,K)
XTRA(2,1,M,K) = -T1*S(M,K)
XTRA(2,2,M,K) = -T1
XTRA(2,3,M,K) = T3
XTRA(3,1,M,K) = -T3*T4*S(M,K)
XTRA(3,2,M,K) = -T3*T4
XTRA(3,3,M,K) = T2
110 CONTINUE
IF(ILPLOT(1) .NE. 0 .AND. IFIRST .NE. 0)CALL PLOTS(BUFFER,2000,15)
NT = 1
WAVE NO = TWO PI*1000.0*FREQ/VELITE
CONST = 0.03248*WAVE NO/DSQRT(FREQ)
OMEGA = TWO PI*FREQ*1000.
KVRACT = DEXP(DLOG(WAVE NO/ALPHA)/3.)
KVRATT = KVRACT**2
AVRKOT = 1./KVRACT
AVRKIT = AVRKOT**2*0.5
DO 130 L=1,NRSLAB
130 NTHSQ(L) = 1.+ALPHA*TOPHT(L)
IFLG = 0
DO 135 M=1,NRSLAB
MM = NRSLAB-M+1
IF(MM .NE. NRSLAB) IFLG=1
135 CALL HTINTL(CAPI,TNORM,IFLG,MM,INTFLG)
Z(1) = ZT
Z(2) = ZR
CALL FTGAIN(Z)
DO 136 M=1,NRSLAB
DO 136 K=1,NRMODE
XTRA(1,1,M,K) = XTRA(1,1,M,K)*FF1(M,K)**2
XTRA(1,2,M,K) = XTRA(1,2,M,K)*FF1(M,K)**2
XTRA(1,3,M,K) = XTRA(1,3,M,K)*FF1(M,K)*FF3(M,K)/FOFR(M,K)
XTRA(2,1,M,K) = XTRA(2,1,M,K)*FF1(M,K)**2
XTRA(2,2,M,K) = XTRA(2,2,M,K)*FF1(M,K)**2
XTRA(2,3,M,K) = XTRA(2,3,M,K)*FF1(M,K)*FF3(M,K)/FOFR(M,K)
XTRA(3,1,M,K) = XTRA(3,1,M,K)*FF1(M,K)*FF3(M,K)/FOFR(M,K)
XTRA(3,2,M,K) = XTRA(3,2,M,K)*FF1(M,K)*FF3(M,K)/FOFR(M,K)
XTRA(3,3,M,K) = XTRA(3,3,M,K)*FF3(M,K)**2/(FOFR(M,K)**2)

```



```

136  CONTINUE
118  IF(XVAL(NRSLAB-1) .GE. 0.) GO TO 111
      DO 112 J=1,NRMODE
      DO 112 K=1,NRMODE
      DO 112 L=1,NRSLAB
112  A(L,K,J) = 0.0
      DO 113 L=2,NRSLAB
      IF(XVAL(NRSLAB+1-L) .GE. 0.) GO TO 114
113  CONTINUE
      NTR = 1
      GO TO 117
114  NTR = NRSLAB+2-L
117  CONTINUE
      DO 116 J=1,NRMODE
      DO 116 K=1,NRMODE
116  IF(K .EQ. J) A(NTR,K,J)=(1.0,0.0)
      NRMO = NRSLAB-1
      DO 401 MM=1,NTR
      M = NTR-MM+1
401  CALL MCSTEP(M)
      IF(IPRNTA .EQ. 0) GO TO 91
      PRINT 905
      DO 451 L=1,NTR
      PRINT 900,L
      DO 451 J=1,NRMODE
      DO 451 K=1,NRMODE
      PRINT 901,J,K,A(L,J,K)
451  CONTINUE
91   IF(IPLTOP .EQ. 1) CALL MCFLD
      IF(IPLTOP .EQ. 2) CALL MCFLD2
      NT = NT+1
      DO 106 ME=1,NRMO
106  XVAL(ME) = XVAL(ME)+DELTAX
      IF(XVAL(NTR) .GE. 0. .AND. NT .LE. NTMAX) GO TO 118
      IF(NT .LE. NTMAX) GO TO 91
      IF(LAST .EQ. 0) GO TO 10
      IF(IDPLOT(1) .NE. 0) CALL PLOT(0.,0.,999)
      RETURN
111  NTR = NRSLAB
      DO 150 J = 1, NRMODE
      DO 150 K = 1, NRMODE
      DO 120 L = 1,NRSLAB
      A(L,K,J) = 0.0
120  CONTINUE
      IF(K .EQ. J) A(NRSLAB,K,J) = (1.0,0.0)
150  CONTINUE
      NRMO = NRSLAB - 1
C     THE LOOP 400 DETERMINES(A)
C     IN SUCCESSIVE SLABS.
      DO 400 MM = 1,NRSLAB
      M = NRSLAB - MM + 1
      CALL MCSTEP(M)
      IF(NRSLAB .LE. 1) RETURN

```

```

400 CONTINUE
   IF(IPRINTA .EQ. 0) GO TO 90
   PRINT 905
   DO 450 L=1,NRSLAB
   PRINT 900,L
   DO 450 J=1,NRMODE
   DO 450 K=1,NRMODE
   PRINT 901,J,K,A(L,J,K)
450 CONTINUE
90  IF(IPLTOP .EQ. 1) CALL MCFLD
   IF(IPLTOP .EQ. 2) CALL MCFLD2
   NT = NT + 1
   DO 105 ME = 1, NRMO
   XVAL(ME) = XVAL(ME) + DELTAX
105 CONTINUE
   IF(NT .LE. NTMAX) GO TO 90
   IF(LAST .EQ. 0) GO TO 10
   IF(IDPLOT(1) .NE. 0) CALL PLOT(C.,J.,999)
   RETURN
201 FORMAT(20A4)
202 FORMAT(' ',20A4)
900 FORMAT(1H ,14X,
$ 'A = TOTAL CONVERSION COEFFICIENTS',6X,'SLAB NUMBER = ',12,/)
901 FORMAT(14X,' J =',12,5X,' K =', 12,5X,' A=',(E15.5,E15.5),/)
905 FORMAT(1H1)
   END

```

```

SUBROUTINE HTINTL(CAPI,NORM,IFLG,M,INTFLG)
C CALCULATE NORMALIZATION INTEGRALS AND INTEGRALS OF HEIGHT GAINS IN
C ADJACENT SLABS.
  IMPLICIT REAL *8(A-H,O-Z)
  COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(5,3,25,5),TOPHT(25),
$      XVAL(25),FREQ,RHOMAX,RHUMIN,DELRHO,DELTAX,EPSLON(25),
$      SIGMA(25),NRSLAB,NRMODE,NTMAX
  COMMON/MCSTOR/A(25,5,5),S(25,5),C(25,5),NTHSQ(25),KVRABT,KVRATT,
$      AVRROT,AVRKTT,CONST,OMEGA,WAVENO
  COMPLEX*16 NTHSQ
  COMPLEX*16 PTHA,H1TA,H2TA,H1PRTA,H2PRTA,HYTHA(5),EYTHA(5),
$  HYTHPA(5),EYTHPA(5)
  COMPLEX*16 THETA,FOFR, A,S,C,SSQ,CSQ,IM/(0.00,1.00)/,NGSQ,
&  SQRROT,RTIORT,PO,PTH,H1O,H2O,H1PRMO,H2PRMO,CAPH1O,CAPH2O,
&  A1ST,A2ND,A3RD,A4TH,DEN12,DEN34,DENMF,NUMMF,
&  H1T,H2T,H1PRMT,H2PRMT,HYTH(5),EYTH(5),HYTHPR(5),EYTHPR(5),
&  HYOPR(5),EYOPR(5),EYO(5),MULT,FAC1,FAC2,NORM(25,5,5),PS(5),
$  CAPI(25,5,5),PHYTH(5),PHYTHP(5),PEYTH(5),PEYTHP(5),PEYO(5),
&  PEYOPR(5),PHYOPR(5),XTRA
  REAL*8 KVRABT,KVRATT
  DATA EPSLNO/8.854340-12/

C
C
  DO 100 K = 1, NRMODE
    SSQ = S(M,K)**2
    CSQ = C(M,K)**2
    NGSQ = (EPSLON(M) - IM*SIGMA(M)/OMEGA)/EPSLNO
    SQRROT = CDSQRT(NGSQ - SSQ)
    RSQR = SQRROT
    IF(RSQR.LT.C.) SQRROT=-SQRROT
    RTIORT = 1./NGSQ*SQRROT
    PO = KVRATT*CSQ
    PTH = KVRATT*(NTHSQ(M)-SSQ)
    CALL MDHNKL(PO,H1O,H2O,H1PRMO,H2PRMO)
    CAPH1O = H1PRMO + AVRKTT*H1O
    CAPH2O = H2PRMO + AVRKTT*H2O
    A1ST = CAPH2O - IM*RTIORT*KVRAOT*H2O
    A2ND = CAPH1O - IM*RTIORT*KVRAOT*H1O
    A3RD = H2PRMO - IM*KVRAOT*SQRROT*H2O
    A4TH = H1PRMO - IM*KVRAOT*SQRROT*H1O
    DEN12 = H2O*A2ND - H1O*A1ST
    DEN34 = H2O*A4TH - H1O*A3RD
    CALL MDHNKL(PTH,H1T,H2T,H1PRMT,H2PRMT)
    HYTH(K) = (H2T*A2ND - H1T*A1ST)/DEN12
    EYTH(K) = (H2T*A4TH - H1T*A3RD)/DEN34*FOFR(M,K)
    HYTHPR(K) = (H2PRMT*A2ND - H1PRMT*A1ST)/DEN12
    EYTHPR(K) = (H2PRMT*A4TH - H1PRMT*A3RD)/DEN34*FOFR(M,K)
    HYOPR(K) = (H2PRMO*A2ND - H1PRMO*A1ST)/DEN12
    EYOPR(K) = (H2PRMO*A4TH - H1PRMO*A3RD)/DEN34*FOFR(M,K)
    IF(IFLG.EQ.0) GO TO 100
    PTHA = KVRATT*(NTHSQ(M+1)-SSQ)
    CALL MDHNKL(PTHA,H1TA,H2TA,H1PRTA,H2PRTA)
    HYTHA(K) = (H2TA*A2ND-H1TA*A1ST)/DEN12
  
```



```

EYTHA(K) = (H2TA*A4TH-H1TA*A3RD)/DEN34*FOFR(M,K)
HYTHPA(K) = (H2PRTA*A2ND-H1PRTA*A1ST)/DEN12
EYTHPA(K) = (H2PRTA*A4TH-H1PRTA*A3RD)/DEN34*FOFR(M,K)
100 EY(K) = FLFR(M,K)
IF (INTFLG .EQ. 1) PRINT 906,M
DO 240 J = 1,NRMODE
DO 240 K = 1,NRMODE
IF (J .EQ. K) GO TO 120
MULT = AVRKOT/((S(M,J) - S(M,K))*WAVENU)
FAC1 = EYTH(K)*EYTHPR(J) - EYTH(J)*EYTHPR(K) + HYTH(K)*HYTHPR(J)
      -HYTH(J)*HYTHPR(K)
FAC2 = -EY(K)*EYOPR(J) + EY(J)*EYOPR(K) - HYOPR(J) + HYOPR(K)
NORM(M,J,K) = MULT*(FAC1+FAC2)
IF (INTFLG .EQ. 1) PRINT 908,M,J,K,NORM(M,J,K)
GO TO 240
120 MULT = 2.0*S(M,J)*KVRAT/WAVENU
PTH = KVRATT*(INTHSQ(M)-S(M,J)**2)
PO = KVRATT*C(M,J)**2
FAC1 = EYTHPR(J)**2 + HYTHPR(J)**2 + PTH*(EYTH(J)**2 + HYTH(J)**2)
FAC2 = -EYOPR(J)**2 - HYOPR(J)**2 - PO*(EY(J)**2 + 1.J)
NORM(M,J,K) = MULT*(FAC1+FAC2)
IF (INTFLG .EQ. 1) PRINT 908,M,J,K,NORM(M,J,K)
240 CONTINUE
IF (IFLG .EQ. 0) GO TO 500
DO 400 K = 1, NRMODE
DO 400 J = 1, NRMODE
MULT = AVRKOT/((PS(J) - S(M,K))*WAVENU)
FAC1 = EYTHA(K)*PEYTHP(J)-PEYTH(J)*EYTHPA(K)
      +HYTHA(K)*PHYTHP(J)-PHYTH(J)*HYTHPA(K)
FAC2 = -EY(K)*PEYOPR(J) + PEY(J)*EYOPR(K) -PHYOPR(J) + HYOPR(K)
CAPI(M,K,J) = MULT*(FAC1+FAC2)
IF (INTFLG .EQ. 1) PRINT 910,M,K,J,CAPI(M,K,J)
400 CONTINUE
500 DO 600 J = 1, NRMODE
PS(J) = S(M,J)
PHYTH(J) = HYTH(J)
PHYTHP(J) = HYTHPR(J)
PEYTH(J) = EYTH(J)
PEYTHP(J) = EYTHPR(J)
PHYOPR(J) = HYOPR(J)
PEY(J) = EY(J)
PEYOPR(J) = EYOPR(J)
600 CONTINUE
720 CONTINUE
RETURN
906 FORMAT('0',20X,'INTEGRALS IN SLAB',13,/)
908 FORMAT(21X,'NORM(',11,',',',11,',',',11,')' =',2D13.6)
910 FORMAT(21X,'CAPI(',11,',',',11,',',',11,')' =',2D13.6)
END

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      SUBROUTINE MCFLD
      IMPLICIT REAL *8(A-H,O-Z)
C     COMPUTE FIELDS FROM XVAL MIN TO XVAL MAX FOR TWO XMTR-KCVR DISTANCES
C     AT DELTAX INTERVALS
C
      COMMON/TERM/NT,NTR
      COMMON/SPLUT/SAVED(402),Y1(3,4,402),Y2(3,4,402)
      COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(3,3,25,5),TOPHT(25),
$      XVAL(25),FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON(25),
$      SIGMA(25),NRSLAB,NRMODE,NTMAX
      COMMON/MCSTOR/A(25,5,5),S(25,5),C(25,5),NTHSQ(25),KVRATT,KVRATT,
$      AVKROT,AVRKT,CONST,OMEGA,WAVENO
      COMMON/MCPLT/R(400),DE(3,4,400),ANG(3,4,400),IDPLOT(10),ISUB,NRP
      COMMON/HTGN/F(3,25,5,2)
      COMMON/HOINPT/GAMMA(4),PHI(4),ZT,ZR
$      ,SINGAM(4),COSGAM(4),SINPHI(4),CUSPHI(4)
      REAL*4 R,DE,ANG,SAVED,Y1,Y2,ANG1(3,4,402),ANG2(3,4,402)
      REAL*8 KVRATT,KVRATT
      COMPLEX*16 SOLNA(5,3,4),THETA,A,S,C,XTRA,TB,TDBL,TA,FOFR,F,NTHSQ,
$      IM/(0.000,1.000)/
      DATA EKAD/6.370D3/
C
C
      ISUB = 1
      MP=-10
      RHO = RHO MIN
600  CONTINUE
      DO 1 LL=2,NRSLAB
      IF(XVAL(NRSLAB+1-LL)-RHO .GE. 0.) GO TO 2
1     CONTINUE
      M=1
      GO TO 3
2     M = NRSLAB+2-LL
3     CONTINUE
      IF(M .EQ. MP) GO TO 720
      DO 710 N=1,NRP
      DO 710 L=1,5
      DO 710 J = 1,NRMODE
      SOLN A(J,L,N) = (0.0,0.0)
      DO 710 K = 1,NRMODE
      IF(M .NE. NTR) GO TO 35
      SOLN A(J,L,N) = SOLN A(J,L,N)
$      +A(M,J,K)*(XTRA(1,L,NTR,K)*F(1,NTR,K,1)*
$COSGAM(N)      +XTRA(2,L,NTR,K)*F(2,NTR,K,1)*SINGAM(N)*
$COSPHI(N)      +XTRA(3,L,NTR,K)*F(3,NTR,K,1)*SINGAM(N)*
$SINPHI(N))
      IF(L .NE. 1) SOLN A(J,L,N) = SOLN A(J,L,N)*S(NTR,K)
      GO TO 710
35  SOLN A(J,L,N) = SOLN A(J,L,N)
$      +A(M,J,K)*(XTRA(1,L,NTR,K)*F(1,NTR,K,1)*
$COSGAM(N)      +XTRA(2,L,NTR,K)*F(2,NTR,K,1)*SINGAM(N)*
$COSPHI(N)      +XTRA(3,L,NTR,K)*F(3,NTR,K,1)*SINGAM(N)*
$SINPHI(N))

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```

$ *CDEXP(-IM*WAVENO*S(NTR,K)*XVAL(NTR-1))
IF(L.NE.1) SOLN A(J,L,N) = SOLN A(J,L,N)*S(NTR,K)
/10 CONTINUE
C
720 CONTINUE
DO 900 N=1,NRP
DO 900 L=1,3
TA = (0.0,0.0)
DO 730 J = 1,NRMODE
IF(M.NE.NTR) GO TO 45
TB = CDEXP(-IM*WAVENO*S(M,J)*RHO)
TA = TA+SOLN A(J,L,N)*TB*F(L,M,J,2)
IF(L.NE.1) TA = TA/S(M,J)
GO TO 730
45 TB = CDEXP(IM*WAVENO*S(M,J)*(XVAL(M)-RHO))
TA = TA+SOLN A(J,L,N)*TB*F(L,M,J,2)
IF(L.NE.1) TA = TA/S(M,J)
730 CONTINUE
TA = TA*CONST/DSQRT(USIN(RHO/ERAO))
TDBL = TA *CDEXP (IM * WAVE NO * RHO)
CALL MAGANG (TDBL, TMAG, TDANG)
TSMAG = TMAG
TSANG = TDANG
TSDB = 8.685890 * DLOG (TSMAG * 1.0E6)
R(ISUB) = RHO
DB(L,N,ISUB) = TSDB
ANG(L,N,ISUB) = TSANG
SAVED(NT) = XVAL(NRSLAB-1)
IF(MOD(ISUB,2).EQ.1) Y1(L,N,NT) = DB(L,N,ISUB)
IF(MOD(ISUB,2).EQ.0) Y2(L,N,NT) = DB(L,N,ISUB)
IF(MOD(ISUB,2).EQ.1) ANG1(L,N,NT) = ANG(L,N,ISUB)
IF(MOD(ISUB,2).EQ.0) ANG2(L,N,NT) = ANG(L,N,ISUB)
900 CONTINUE
RHO = RHO + DEL RHO
ISUB = ISUB+1
MP = M
IF (RHO.LE.RHO MAX) GO TO 600
ISUB = ISUB-1
IF(NT.NE.NTMAX) RETURN
DO 930 N=1,NRP
PGAMMA = GAMMA(N)/1.745329D-2
PPHI = PHI(N)/1.745329D-2
PRINT 910
PRINT 927,PGAMMA,PPHI,ZT,ZR
PRINT 920
PRINT 925
927 FORMAT(' GAMMA(DEG)=' ,F6.1,' PHI(DEG)=' ,F6.1,' ZT(KM)=' ,F10.3,
$ ' ZR(KM)=' ,F10.3)
DO 930 JJ=1,NTMAX
PRINT 908,SAVED(JJ),Y1(1,N,JJ),ANG1(1,N,JJ),Y1(3,N,JJ),
$ ANG1(3,N,JJ),Y1(2,N,JJ),ANG1(2,N,JJ),Y2(1,N,JJ),ANG2(1,N,JJ),
$ Y2(3,N,JJ),ANG2(3,N,JJ),Y2(2,N,JJ),ANG2(2,N,JJ)
908 FORMAT(' ',F7.1,6(1X,F8.3,1X,F7.2))

```



```

930  CONTINUE
      IF (IDPLOT(1).EQ.0) RETURN
      CALL MCPLTS
      RETURN
910  FORMAT('1',
$ ' ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR
$ DISTANCE(D)',//)
920  FORMAT(' ',26X,'FIELD AT RHOMIN',34X,'FIELD AT RHOMAX')
925  FORMAT(' ',3X,'D',3X,2(2X,'EZ(DB)',2X,'EZ(ANG)',2X,'EY(Db)',2X,
$ 'EY(ANG)',2X,'EX(Db)',2X,'EX(ANG)'))
      END

```

```

SUBROUTINE MCFLD2
  IMPLICIT REAL *8(A-H,O-Z)
C  COMPUTE FIELDS FROM RHO MIN TO RHO MAX
C  AT DEL RHO INTERVALS.
C
  COMMON/TERM/NT,NTR
  COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(3,3,25,5),TOPHT(25),
$      XVAL(25),FREQ,RHOMAX,RHUMIN,DELRHO,DELTAX,EPSLON(25),
$      SIGMA(25),NRSLAB,NRMODE,NTMAX
  COMMON/MCSTOR/A(25,5,5),S(25,5),C(25,5),NTHSQ(25),KVRADT,KVRATT,
$      AVRKOT,AVRKT,CONST,OMEGA,WAVENO
  COMMON/MCPLDT/R(400),DB(3,4,400),ANG(3,4,400),IDPLOT(1),ISUB,NRP
  COMMON/HTGN/F(3,25,5,2)
  COMMON/HGINPT/GAMMA(4),PHI(4),ZT,ZR
$  ,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)
  REAL*4 R,DB,ANG
  COMPLEX*16 SOLNA(5,3,4)
  COMPLEX*16 THETA,A,S,C,XTRA,          TB,TDBL,IM/(0.00,1.00)/,TA,
$  FOFR,F,NTHSQ
  REAL*8 KVRADT,KVRATT
  DATA ERAD/6.37003/

C
C
  PRINT 910
  ISUB = 1
  DBMAX = -1000.0
  RHO = RHO MIN
  M = NTR
  X = RHO - 1.0
600  CONTINUE
  700  IF (RHO.LE.X) GO TO 720
  DO 710 N=1,NRP
  DO 710 L=1,3
  DO 710 J = 1,NRMODE
  SOLN A(J,L,N) = (0.0,0.0)
  DO 710 K = 1,NRMODE
  IF(M.NE.NTR) GO TO 35
  SOLN A(J,L,N) = SOLN A(J,L,N)
$      +A(M,J,K)*(XTRA(1,L,NTR,K)*F(1,NTR,K,1)*
$COSGAM(N)      +XTRA(2,L,NTR,K)*F(2,NTR,K,1)*SINGAM(N)*
$COSPHI(N)      +XTRA(3,L,NTR,K)*F(3,NTR,K,1)*SINGAM(N)*
$SINPHI(N))
  IF(L.NE.1) SOLN A(J,L,N) = SOLN A(J,L,N)*S(NTR,K)
  GO TO 710
35  SOLN A(J,L,N) = SOLN A(J,L,N)
$      +A(M,J,K)*(XTRA(1,L,NTR,K)*F(1,NTR,K,1)*
$COSGAM(N)      +XTRA(2,L,NTR,K)*F(2,NTR,K,1)*SINGAM(N)*
$COSPHI(N)      +XTRA(3,L,NTR,K)*F(3,NTR,K,1)*SINGAM(N)*
$SINPHI(N))
$  *CDEXP(-IM*WAVENO*S(NTR,K)*XVAL(NTR-1))
  IF(L.NE.1) SOLN A(J,L,N) = SOLN A(J,L,N)*S(NTR,K)
710  CONTINUE
  M = M - 1

```

```

      X = 1.0E6
      IF (M.GT.0) X = XVAL(M)
      GO TO 700

C
720  CONTINUE
      DO 900 N=1,NRP
      DO 900 L=1,3
      TA = (0.0,0.0)
      DO 730 J = 1,NRMODE
      IF (M+1 .NE. NTR) GO TO 45
      TB = CDEXP(-IM*WAVENO*S(M+1,J)*RHO)
      TA = TA+SOLN A(J,L,N)*TB*F(L,M+1,J,2)
      IF (L .NE. 1) TA = TA/S(M+1,J)
      GO TO 730
45  TB = CDEXP(IM*WAVENO*S(M+1,J)*(XVAL(M+1) - RHO))
      TA = TA+SOLN A(J,L,N)*TB*F(L,M+1,J,2)
      IF (L .NE. 1) TA = TA/S(M+1,J)
730  CONTINUE
      TA = TA*CONST/DSQRT(DSIN(RHO/ERAD))
      TDBL = TA * CDEXP (IM * WAVE NO * RHO)
      CALL MAGANG (TDBL, TDMAG, TDANG)
      TSMAG = TDMAG
      TSANG = TDANG
      TSDb = 8.685890 * DLOG (TSMAG * 1.0E6)
      R(ISUB) = RHO
      DB(L,N,ISUB) = TSDb
      ANG(L,N,ISUB) = TSANG
900  CONTINUE
      RHO = RHO + DEL RHO
      ISUB = ISUB+1
      IF (RHO .LE. RHOMAX) GO TO 600
      ISUB = ISUB-1
      DO 930 N=1,NRP
      PGAMMA = GAMMA(N)/1.745329D-2
      PPHI = PHI(N)/1.745329D-2
      PRINT 927,PGAMMA,PPHI,ZT,ZR
      PRINT 928
      PRINT 929
927  FORMAT('0',11X,'GAMMA(DEG)=' ,F6.1,' PHI(DEG)=' ,F6.1,' ZT(KM)=' ,
$      F10.3,' ZR(KM)=' ,F10.3)
928  FORMAT(22X,'Z',37X,'X',37X,'Y')
929  FORMAT(2X,3(9X,'RHO(KM)',3X,'AMP(DB)',3X,'ANG(DEG)'))
      DO 930 J=1,ISUB
      PRINT 908,R(J),DB(1,N,J),ANG(1,N,J),R(J),DB(2,N,J),ANG(2,N,J),R(J)
      ,DB(3,N,J),ANG(3,N,J)
930  CONTINUE
      IF (IDPLOT(1).EQ.0) RETURN
      CALL MCPLT2
      RETURN
908  FORMAT(2X,3(7X,F10.2,F10.5,F10.4))
910  FORMAT('1',10X,
$      'ELECTRIC FIELD STRENGTH AS A FUNCTION OF RHO',//)
      END

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SUBROUTINE MCPLTS
C MCPLTS GENERATES TWO PLOTS (FIELD AMPLITUDE IN DB ABOVE A
C MICRO VOLT PER METER FOR 1 KW RADIATED POWER VERSUS TRANSMITTER-
C TERMINATOR DISTANCE FOR TWO RECEIVER POSITIONS).
COMMON/TERM/NT,NTR
COMMON/SPLOT/SAVED(402),Y1(3,4,402),Y2(3,4,402)
COMMON/MCPLT/R(400),DB(3,4,400),ANG(3,4,400),IDPLOT(10),ISUB,NRP
COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
COMMON/HGINPT/GAMMA(4),PHI(4),ZT,ZR
1 ,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)
COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(3,3,25,5),TOPHT(25),
1 XVAL(25),FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON(25),
2 SIGMA(25),NRSLAB,NRMODE,NTMAX
COMPLEX*16 THETA,FOFR,XTRA
REAL*8 XVAL,FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON,SIGMA,TOPHT
REAL*8 SINGAM,COSGAM,SINPHI,COSPHI
REAL*8 GAMMA,PHI,ZT,ZR
REAL XCURVE(2)/0.,1./,YCURV1(2)/2*0./,YCURV2(2)/2*.2/,
3 YCURV3(2)/2*.4/,YCURV4(2)/2*.6/
DIMENSION Y(400)
DIMENSION GAMMA(4),PHI(4)
COMPLEX*16 COMP(3)/% COMPONENT ' , 'X COMPONENT ' ,
4 'Y COMPONENT ' /
DO 900 I=1,2
DO 900 IBEGIN =1,3
CALL BGNPL(IBEGIN)
CALL YAXANG(0.)
CALL INTAXS
CALL PAGE(SIZEX+3.,SIZEY+3.)
CALL PHYSGR(1.5,1.2)
CALL TITLE(' ',1,'TRANSMITTER-TERMINATOR DISTANCE(KM)',35,
5 'DB ABOVE 1 UV/M FOR 1 KW',24,SIZEX,SIZEY)
CALL GRAPH(XMIN,XINC,YMIN,YINC)
DO 600 J=1,NRP
GAMMA(J) = GAMMA(J)/1.745329D-2
PHI(J) = PHI(J)/1.745329D-2
IF(J.EQ. 1) CALL RESET('DASH')
IF(J.EQ. 2) CALL DOT
IF(J.EQ. 3) CALL CHNDOT
IF(J.EQ. 4) CALL DASH
DO 500 K=1,NTMAX
IF(I.EQ. 1) Y(K)=Y1(IBEGIN,J,K)
IF(I.EQ. 2) Y(K)=Y2(IBEGIN,J,K)
500 CONTINUE
CALL CURVE(SAVED,Y,NTMAX,0)
600 CONTINUE
CALL MESSAG(IDPLOT,40,1.,9.3)
CALL MESSAG(COMP(IBEGIN),16,1.,9.1)
CALL MESSAG('FREQ = ',7,1.,8.9)
CALL REALNO(FREQ,3,1.7,8.9)
CALL MESSAG('ZT = ' ZR = ',17,1.,8.7)
CALL REALNO(ZT,2,1.70,8.7)
CALL REALNO(ZR,2,3.40,8.7)

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CALL MESSAG('RECEIVER DISTANCE = ',20,1.0,8.5)
IF(I.EQ. 1) CALL REALNO(RHUMIN,1,3.5,8.5)
IF(I.EQ. 2) CALL REALNO(RHOMAX,1,3.5,8.5)
CALL MESSAG('GAMMA =          PHI = ',20,6.0,9.1)
CALL REALNO(GAMMAD(1),1,7.0,9.1)
CALL REALNO(PHID(1),1,8.5,9.1)
CALL MESSAG('GAMMA =          PHI = ',20,6.0,8.9)
CALL REALNO(GAMMAD(2),1,7.0,8.9)
CALL REALNO(PHID(2),1,8.5,8.9)
CALL MESSAG('GAMMA =          PHI = ',20,6.0,8.7)
CALL REALNO(GAMMAD(3),1,7.0,8.7)
CALL REALNO(PHID(3),1,8.5,8.7)
CALL MESSAG('GAMMA =          PHI = ',20,6.0,8.5)
CALL REALNO(GAMMAD(4),1,7.0,8.5)
CALL REALNO(PHID(4),1,8.5,8.5)
CALL ENDGR(1)
CALL UKEL(9.7,8.56)
CALL TITLE(' ',1,' ',0,' ',0,1.,1.)
CALL GRAPH(0.,1.,0.,1.)
CALL RESET('DASH')
CALL CURVE(XCURVE,YCURV4,2,0)
CALL DOT
CALL CURVE(XCURVE,YCURV3,2,0)
CALL CHNDOT
CALL CURVE(XCURVE,YCURV2,2,0)
CALL DASH
CALL CURVE(XCURVE,YCURV1,2,0)
CALL ENDPL(1,BEGIN)
900 CONTINUE
RETURN
END

```

```

SUBROUTINE MCPLT2
C MCPLT2 GENERATES ONE PLOT (FIELD AMPLITUDE IN DB ABOVE A MICRO VOLT
C PER METER FOR 1 KW RADIATED POWER VERSUS DISTANCE FROM TRANSMITTER).
COMMON/MC PLOT/R(400),DB(3,4,400),ANG(3,4,400),IDPLOT(1),ISUB,NRP
COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
COMMON/HOINPT/GAMMA(4),PHI(4),ZT,ZR
$ ,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)
COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(3,3,25,5),TOPHT(25),
$ XVAL(25),FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON(25),
$ SIGMA(25),NRSLAB,NRMODE,NTMAX
COMPLEX*16 THETA,FOFR,XTRA
REAL*8 XVAL,FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON,SIGMA,TOPHT
REAL*8 GAMMA,PHI,ZT,ZR
REAL*8 SINGAM,COSGAM,SINPHI,COSPHI
REAL XCURVE(2)/0.,1./,YCURV1(2)/2*0./,YCURV2(2)/2*.2/,
$ YCURV3(2)/2*.4/,YCURV4(2)/2*.6/
DIMENSION Y(400)
DIMENSION GAMMAD(4),PHID(4)
COMPLEX*16 COMP(3)/1/2 COMPONENT ' , 'X COMPONENT ' ,
$ 'Y COMPONENT ' /
DO 900 IBEGIN =1,3
CALL BGNPL(IBEGIN)
CALL YAXANG(0.)
CALL INTAXS
CALL PAGE(11.,11.)
CALL TITLE(' ', -1, 'RHO(KM)', 7, 'DB ABOVE 1 UV/M FOR 1 Kw', 24,
$ SIZEX,SIZEY)
CALL GRAPH(XMIN,XINC,YMIN,YINC)
DO 600 J=1,NRP
GAMMAD(J) = GAMMA(J)/1.745329D-2
PHID(J) = PHI(J)/1.745329D-2
IF(J.EQ. 1) CALL RESET('DASH')
IF(J.EQ. 2) CALL DOT
IF(J.EQ. 3) CALL CHNDOT
IF(J.EQ. 4) CALL DASH
DO 500 K=1,ISUB
Y(K) = DB(IBEGIN,J,K)
500 CONTINUE
CALL CURVE(R,Y,ISUB,0)
600 CONTINUE
CALL MESSAG(IDPLOT,40,4.,9.5)
CALL MESSAG(COMP(IBEGIN),16,4.,9.3)
CALL MESSAG('FREQ = ',7,4.,9.1)
CALL REALND(FREQ,3,4.7,9.1)
CALL MESSAG('ZT = ' ZR = ',17,4.,8.9)
CALL REALND(ZT,2,4.84,8.9)
CALL REALND(ZR,2,6.52,8.9)
CALL MESSAG('GAMMA = ' PHI = ',20,4.,8.7)
CALL REALND(GAMMAD(1),1,5.0,8.7)
CALL REALND(PHID(1),1,6.5,8.7)
CALL MESSAG('GAMMA = ' PHI = ',20,4.,8.5)
CALL REALND(GAMMAD(2),1,5.0,8.5)
CALL REALND(PHID(2),1,6.5,8.5)

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CALL MESSAG('GAMMA =      PHI = ',20,4.,8.3)
CALL REALNO(GAMMAD(3),1,5.0,8.3)
CALL REALNO(PHID(3),1,6.5,8.3)
CALL MESSAG('GAMMA =      PHI = ',20,4.,8.1)
CALL REALNO(GAMMAD(4),1,5.0,8.1)
CALL REALNO(PHID(4),1,6.5,8.1)
CALL ENDGR(1)
CALL PHYSOF(8.,9.)
CALL TITLE(' ',1,' ',0,' ',0,1.,1.)
CALL GRAPHIO.,1.,0.,1.)
CALL RESET('DASH')
CALL CURVE(XCURVE,YCURV4,2,0)
CALL DOT
CALL CURVE(XCURVE,YCURV3,2,0)
CALL CHNDOT
CALL CURVE(XCURVE,YCURV2,2,0)
CALL DASH
CALL CURVE(XCURVE,YCURV1,2,0)
CALL ENDPL(1BEGIN)
900 CONTINUE
RETURN
END

```

```

      SUBROUTINE MCSTEP(M)
C   COMPUTE GENERALIZED MODE CONVERSION COEFFICIENTS.
      IMPLICIT REAL *8(A-H,O-Z)
      COMMON/TERM/NT,NTR
      COMMON/CAP/CAPI(25,5,5),TNORM(25,5,5)
      COMMON/MCINPT/THETA(25,5),FOF(25,5),XTRA(3,3,25,5),TOPHT(25),
      &          XVAL(25),FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSLON(25),
      &          SIGMA(25),NRSLAB,NRMODE,NTMAX
      COMMON/MCSTOK/A(25,5,5),S(25,5),C(25,5),NTHSQ(25),KVRADT,KVRATT,
      &          AVRKUT,AVRKT,CONST,OMEGA,WAVEND
      COMPLEX*16 CDEXP
      COMPLEX*16 NTHSQ
      COMPLEX*16 THETA,FOF,A,S,C,TNORM,CAPI,
      &          IM/(0.00,1.00)/,B(5),ANS(5),TS(5,5),XTRA
      REAL*8 KVRADT,KVRATT
      REAL*4 ERR

C
C
      MP = M+ 1
      IF(M .EQ. NTR) RETURN
      DO 17 N = 1,NRMODE
17    B(N) = (0.,0.)
      IF(MP .EQ. NTR) GO TO 21
      DO 29 K = 1,NRMODE
      DO 33 L = 1,NRMODE
      DO 35 J = 1,NRMODE
      TS(L,J) = TNORM(M,L,J)
35    B(L) = B(L) +A(MP,J,K)*CDEXP(-IM*WAVEND*S(MP,J) *(XVAL(M) -
      &          XVAL(MP)))*CAPI(M,L,J)
      CALL CLINEQ(TS,B,ANS,NRMODE,5,0,ERR)
      DO 27 I = 1,NRMODE
27    A(M,I,K) = ANS(I)*S(M,I)/S(NTR,K)
      DO 18 N=1,NRMODE
18    B(N) = (0.,0.)
29    CONTINUE
      GO TO 24
21    DO 25 K = 1,NRMODE
      DO 25 LL=1,NRMODE
      DO 25 L = 1,NRMODE
      TS(LL,L) = TNORM(M,LL,L)
25    B(L) = CAPI(M,L,K)
      CALL CLINEQ(TS,B,ANS,NRMODE,5,0,ERR)
      DO 35 J = 1,NRMODE
35    A(M,J,K) = ANS(J)*S(M,J)/S(NTR,K)
23    CONTINUE
24    CONTINUE
      RETURN
      END

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SUBROUTINE MDHNKL (Z,H1,H2,H1PRME,H2PRME)
C  COMPUTE MODIFIED HANKEL FUNCTIONS OF ORDER ONE THIRD
      IMPLICIT REAL *8 (A-H,O-Z)
      COMPLEX*16 CDSQRT,CDEXP
      REAL*8 CDABS
      COMPLEX*16 Z,I,H1,H2,H1PRME,H2PRME,ZPOWER,TERM1,TERM2,
$          TERM3,ZTERM,TERM,SUM1,SUM2,SUM3,SUM4,SQRTZn,
$          EXP1,EXP2,EXP3,EXP4,EXP5,GM2F,GPMFP,MPOWER,BETA,RTZ,
$          CONST1,CONST2,CONST3,CONST4
      DIMENSION A(23), B(23), C(23), D(23), CAP(14)
      DATA A/
$  9.304367169300000D-01,3.10145572309700D 01,2.06763714873160D 02,
$  5.74343652425450D 02,8.70217655150080D 02,8.28778719228640D 02,
$  5.41685437404340D 02,2.57945446383020D 02,9.34584950663100D 01,
$  2.66263518707400D 01,6.12100043005600D 00,1.15928036443000D 00,
$  1.84012759441000D-01,2.48330309640000D-02,2.88420801000000D-03,
$  2.91334142000000D-04,2.58274950000000D-05,2.02568600000000D-06,
$  1.41557000000000D-07,8.87000000000000D-09,5.01000000000000D-10,
$  2.60000000000000D-11,1.00000000000000D-12/
      DATA B/
$  6.78298725140000D-01,1.13049767524000D 01,5.58332321545100D 01,
$  1.19629404787350D 02,1.53371031778650D 02,1.27809195148880D 02,
$  7.47422182157200D 01,3.23559386215200D 01,1.07853128738400D 01,
$  2.85325737403000D 00,6.13603756351000D-01,1.09376780098000D-01,
$  1.64229399550000D-02,2.10550512200000D-03,2.33167783000000D-04,
$  2.25282890000000D-05,1.91567100000000D-06,1.44470000000000D-07,
$  9.72900000000000D-09,5.89000000000000D-10,3.20000000000000D-11,
$  2.00000000000000D-12,0.00000000000000D 00/
      DATA C/
$  4.65218358460000D-01,6.20291144619000D 00,2.58454645591500D 01,
$  5.22130593114000D 01,6.21584039421500D 01,4.87516893663900D 01,
$  2.70842718702200D 01,1.12150194079600D 01,3.59455750255000D 00,
$  9.18150064510000D-01,1.91281263439000D-01,3.31222966990000D-02,
$  4.84244103800000D-03,6.05683682000000D-04,6.55501820000000D-05,
$  6.19859900000000D-06,5.16550000000000D-07,3.82200000000000D-08,
$  2.52800000000000D-09,1.50000000000000D-10,8.00000000000000D-12,
$  0.00000000000000D 00,0.00000000000000D 00/
      DATA D/
$  6.78298725140000D-01,4.52199150096200D 01,3.76832625080150D 02,
$  1.19629404787350D 03,1.99382341312250D 03,2.04947090382060D 03,
$  1.42010214609865D 03,7.11830649673510D 02,2.69632821846030D 02,
$  7.98912064729000D 01,1.90217158268800D 01,3.71831052333900D 00,
$  6.07648778323000D-01,8.42202048960000D-02,1.00262148690000D-02,
$  1.03630127800000D-03,9.38678690000000D-05,7.51243500000000D-06,
$  5.35074000000000D-07,3.41350000000000D-08,1.96200000000000D-09,
$  1.02000000000000D-10,5.00000000000000D-12/
      DATA CAP/
$  1.04166666666667D-01,8.35503472222222D-02,1.28226574556327D-01,
$  2.91849026464140D-01,8.81627267443758D-01,3.32140828186277D 00,
$  1.49957629868626D 01,7.89230150115870D 01,4.74451536868000D 02,
$  3.20749009100000D 03,2.40865496000000D 04,1.98923125000000D 05,
$  1.79190200000000D 06,1.74845770000000D 07/

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DATA I/(0.00,1.00)/
DATA ROOT3/1.732050807568880 00/
DATA ALPHA/8.536672166389510-01/
DATA CONST1/( 2.588190451025220-01, -9.659253262890670-01)/
DATA CONST2/( 2.588190451025220-01, 9.659253262890670-01)/
DATA CONST3/(-9.659253262890670-01, 2.588190451025220-01)/
DATA CONST4/(-9.659253262890670-01, -2.588190451025220-01)/

C
ZPOWER=1.0
SUM3=0.0
SUM4=0.0
ZMAG=CABS(Z)
IF(ZMAG .GT. 4.2) GO TO 70
IF(ZMAG .GE. 3.2) GO TO 10
N=12
GO TO 30
10 IF(ZMAG .GE. 4.1) GO TO 20
N=15
GO TO 30
20 N=25
30 SUM1=0.
SUM2=0.
ZTERM=-Z**3/200.0
DO 50 M=1,N
SUM1=SUM1+A(M)*ZPOWER
SUM2=SUM2+B(M)*ZPOWER
SUM3=SUM3+C(M)*ZPOWER
SUM4=SUM4+D(M)*ZPOWER
ZPOWER=ZPOWER*ZTERM
IF(CABS(ZPOWER) .LE. 1.00-30) GO TO 60
50 CONTINUE
60 GM2F=1*(Z*SUM2-2.*SUM1)/ROOT3
GPMFP=1*(SUM4+2.*Z*SUM3)/ROOT3
H1=Z*SUM2+GM2F
H2=H1-2.0*GM2F
H1PRME=SUM4+GPMFP
H2PRME=H1PRME-2.0*GPMFP
RETURN

C
70 SUM1=1.0
SUM2=1.0
RTZ=CDSQRT(Z)
SQRTZB=RTZ*Z
ZTERM=1/SQRTZB
MPower=1.0
TERM=-1.5/Z
DO 80 M=1,14
ZPOWER=ZPOWER*ZTERM
MPower=MPower*(-ZTERM)
TERM1=CAP(M)*ZPOWER
TERM2=CAP(M)*MPower
SUM1=SUM1+TERM1
SUM2=SUM2+TERM2

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```

SUM3=SUM3+M*TERM1
SUM4=SUM4+M*TERM2
80  CONTINUE
    SUM3=SUM3*TERM
    SUM4=SUM4*TERM
    EXP1=CDEXP(2.*I*SQRTZB/3.)
    EXP2=EXP1*CONST1
    EXP3=CONST2/EXP1
    EXP4=CONST3*EXP1
    EXP5=CONST4/EXP1
    BETA=ALPHA/CDSQRT(RTZ)
    ZREAL=Z
    ZIMAG=-I*Z
    IF (ZREAL.GE.0.0.OR.ZIMAG.GE.0.0)GO TO 90
    H1=BETA*(EXP2*SUM2+EXP5*SUM1)
    H1PKME=BETA*(EXP2*(SUM2*(-0.25/Z+I*RTZ)+SUM4)+EXP5*(SUM1*(-0.25/Z
$      -I*RTZ)+SUM3))
    GO TO 110
90  H1=BETA*EXP2*SUM2
    H1PKME=BETA*EXP2*(SUM2*(-0.25/Z+I*RTZ)+SUM4)
110 IF (ZREAL.GE.0.0.OR.ZIMAG.LT.0.0)GO TO 120
    H2=BETA*(EXP3*SUM1+EXP4*SUM2)
    H2PKME=BETA*(EXP3*(SUM1*(-0.25/Z-I*RTZ)+SUM3)+EXP4*(SUM2*(-0.25/Z
$      +I*RTZ)+SUM4))
    RETURN
120 H2=BETA*EXP3*SUM1
    H2PKME=BETA*EXP3*(SUM1*(-0.25/Z-I*RTZ)+SUM3)
    RETURN
    END

```

```

SUBROUTINE MAGANG(ARG,MAG,ANGLE)
IMPLICIT REAL *8(A-H,O-Z)
REAL*8 DSQRT,DARCOS
COMPLEX*16 ARG,IM/(0.00,1.00)/
REAL*8 MAG
DATA RTDEG/57.29577951/
ENTRY MAGANG(ARG,MAG,ANGLE)
ARGAL = ARG
ARGMAG = IM*ARG
MAG = DSQRT(ARGAL*ARGAL + ARGMAG*ARGMAG)
IF(MAG .EQ. 0.0) GO TO 10
COSQ = ARGAL/MAG
IF (COSQ .LT. -1.0.AND. COSQ .GT. -1.01) COSQ = -1.0
IF(COSQ .GT. 1.0.AND. COSQ .LT. 1.01) COSQ = 1.0
5 ANGLE = DARCOS(COSQ)*RTDEG
IF(ARGMAG .LT. 0.0) ANGLE = 360.0 - ANGLE
RETURN
10 COSQ = 0.0
GO TO 5
END

```



```

      SUBROUTINE HTGAIN(Z)
C   COMPUTE EZ,EX,EY HEIGHT GAINS FOR TRANSMITTER AND RECEIVER.
      IMPLICIT COMPLEX*16(A-H,O-Z)
      COMMON/HGTEMP/FF1(25,5),FF3(25,5)
      COMMON/HTGN/F(3,25,5,2)
      COMMON/MCINPT/THETA(25,5),FOFR(25,5),XTRA(3,3,25,5),TOPHT(25),
$      XVAL(25),FREQ,RHOMAX,RHOMIN,DELPHO,DELTAX,EPSLON(25),
$      SIGMA(25),NRSLAB,NRMODE,NTMAX
      COMMON/MCSTOR/A(25,5,5),S(25,5),C(25,5),NTHSQ(25),KVRADT,KVRATT,
$      AVRKOT,AVRKTT,CONST,OMEGA,WAVENO
      COMPLEX*16 CDSQRT
      REAL*8 DEXP
      COMPLEX*16 NGSQ,IM/(0.00,1.00)/,NTHSQ
      REAL*8 XVAL,FREQ,RHOMAX,RHOMIN,DELPHO,DELTAX,EPSLON,SIGMA
      REAL*8 KVRADT,KVRATT,AVRKOT,AVRKTT,CONST,OMEGA,WAVENO
      REAL*8 Z(2),EPSLNO/8.854340-12/,ALPHA/3.140-4/,FAC1
      REAL*8 RSQR
      REAL*8 TOPHT
      DO 100 M=1,NRSLAB
      NGSQ = (EPSLON(M)-IM*SIGMA(M)/OMEGA)/EPSLNO
      DO 100 K=1,NRMODE
      SSQ = S(M,K)**2
      SQRDUT = CDSQRT(NGSQ-SSQ)
      CSQ = C(M,K)**2
      RSQR = SQRDUT
      IF(RSQR.LT.0.) SQRDUT=-SQRDUT
      DO 100 IZ=1,2
      Q = KVRATT*(CSQ+ALPHA*Z(IZ))
      Q0 = KVRATT*CSQ
      CALL MDHNKL(Q,H10,H20,H1PRM0,H2PRM0)
      CALL MDHNKL(Q,H1,H2,H1PRM,H2PRM)
      CAPH10 = H1PRM0+AVRKTT*H10
      CAPH20 = H2PRM0+AVRKTT*H20
      FAC2 = IM*KVRADT*SQRDUT
      FAC3 = FAC2/NGSQ
      F1 = -(CAPH20-FAC3*H20)
      F2 = CAPH10-FAC3*H10
      F3 = -(H2PRM0-FAC2*H20)
      F4 = H1PRM0-FAC2*H10
      FAC1 = DEXP(ALPHA/2.*Z(IZ))
      F(1,M,K,IZ) = FAC1*(F1*H1+F2*H2)
      F(2,M,K,IZ) = ALPHA/(IM*2.*WAVENO)*F(1,M,K,IZ)+1./IM*AVRKOT*FAC1*
$      (F1*H1PRM+F2*H2PRM)
      F(3,M,K,IZ) = F3*H1+F4*H2
      FF1(M,K) = F1*H10+F2*H20
      FF3(M,K) = F3*H10+F4*H20
      F(1,M,K,IZ) = F(1,M,K,IZ)/FF1(M,K)
      F(2,M,K,IZ) = F(2,M,K,IZ)/FF1(M,K)
      F(3,M,K,IZ) = F(3,M,K,IZ)*FOFR(M,K)/FF3(M,K)
100  CONTINUE
      RETURN
      END

```

```

      SUBROUTINE CLIN EQ (A, B, X, N,
      $   N DIM, IFLAG, ERR)
C
C   CLIN EQ USES L-U DECOMPOSITION TO
C   FIND THE TRIANGULAR MATRICES L, U
C   SUCH THAT  $L * U = A$ . L AND U ARE
C   STORED IN A. THIS FORM IS USED WITH
C   BACK-SUBSTITUTION TO FIND THE SOLN
C   X OF  $A * X = L * U * X = B$ .
C   N IS THE NUMBER OF EQUATIONS AND
C   N DIM IS THE DIMENSION OF ALL ARRAYS
C   IN THE PARAMETER LIST.
C
C   IF IFLAG = 0, L, U, AND X ARE
C   COMPUTED.
C   IF IFLAG IS NON-ZERO, IT IS ASSUMED
C   THAT L AND U HAVE BEEN COMPUTED IN
C   A PREVIOUS CALL AND ARE STILL STORED
C   IN A. THUS ONLY X IS COMPUTED.
C   ERR IS THE ESTIMATED RELATIVE
C   ERROR OF THE SOLUTION VECTOR.
C
      COMPLEX*16 A, B, X, T
      INTEGER*2 IROW
      DIMENSION A(N DIM, N DIM),
      $   B(N DIM), X(N DIM)
      DIMENSION IROW(50), Q(50)
      DATA EPS /1.0E-15/
C
C
      IF (N.GT.50) GO TO 900
      IF (IFLAG.NE.0) GO TO 600
      DO 050 I = 1,N
      Q(I) = 0.0
      DO 040 J = 1,N
      QQ = CDABS (A(I,J))
      040 IF (Q(I).LT.QQ) Q(I) = QQ
      IF (Q(I).EQ.0.0) GO TO 901
      050 CONTINUE
      ERR = EPS
      PPIV = 0.0
      DO 100 I = 1,N
      100 IROW(I) = I
C
      DO 500 L = 1,N
      PIVOT = 0.0
      K = L - 1
      DO 240 I = L,N
      IF (K.LT.1) GO TO 230
      DO 220 J = 1,K
      220 A(I,L) = A(I,L) - A(J,L) * A(I,J)
      230 F = CDABS (A(I,L)) / Q(I)
      IF (PIVOT.GT.F) GO TO 240

```

```

PIVOT = F
NPIVOT = I
240 CONTINUE
IF (PIVOT.EQ.0.0) GO TO 901
IF (PPIV.LE.PIVOT) GO TO 250
ERR = ERR * PPIV / PIVOT
IF (ERR.GE.1.0) GO TO 901
250 PPIV = PIVOT
IF (NPIVOT.EQ.L) GO TO 280
J(NPIVOT) = J(L)
J = IROW(L)
IROW(L) = IROW(NPIVOT)
IROW(NPIVOT) = J
DO 260 I = 1,N
T = A(L,I)
A(L,I) = A(NPIVOT,I)
A(NPIVOT,I) = T
260 CONTINUE
280 IF (L.EQ.N) GO TO 500
T = (1.000,0.000) / A(L,L)
K = L + 1
M = L - 1
DO 450 I = K,N
IF (M.LT.1) GO TO 400
DO 350 J = 1,M
350 A(L,I) = A(L,I) - A(L,J) * A(J,I)
400 A(L,I) = T * A(L,I)
450 CONTINUE
500 CONTINUE
IF (ERR.GT.1.0E-5) PRINT 998, ERR

```

C
C

```

600 DO 620 I = 2,N
620 X(I) = (0.000,0.000)
J = IROW(I)
X(I) = B(J) / A(I,I)
DO 700 I = 2,N
J = IROW(I)
K = I - 1
DO 650 L = 1,K
650 X(I) = X(I) + A(I,L) * X(L)
X(I) = (B(J) - X(I)) / A(I,I)
700 CONTINUE
K = N - 1
DO 800 I = 1,K
J = N - I
M = J + 1
DO 800 L = M,N
X(J) = X(J) - X(L) * A(J,L)
800 CONTINUE
RETURN

```

C

```

900 PRINT 999

```



```

      ERR = 1.0
      RETURN
901 PRINT 997
      ERR = 1.0
      RETURN
997 FORMAT ('!ERROR IN CLIN EQ, MATRIX IS SINGULAR')
998 FORMAT ('! CAUTION-',
      $ ' CLIN EQ HAS DECOMPOSED AN ILL-CONDITIONED MATRIX.',/,
      $ ' RESULTS WILL HAVE RELATIVE ERROR =',E11.2)
999 FORMAT ('!ERROR IN CLIN EQ, MATRIX SIZE GREATER THAN 50')
      END

```

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